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AICRP ON POST-HARVEST ENGINEERING AND TECHNOLOGY JUNAGADH CENTRE

ANNUAL REPORT

(2023-2024)

To be presented
at
ICAR-Central Institute of Post-Harvest Engineering and Technology,
Ludhiana-141004, Punjab

During
13-15 February, 2024

AICRP ON POST-HARVEST ENGINEERING AND TECHNOLOGY
COLLEGE OF AGRICULTURAL ENGINEERING & TECHNOLOGY
JUNAGADH AGRICULTURAL UNIVERSITY
JUNAGADH – 362 001 (GUJARAT)

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ANNUAL REPORT
2023- 2024

ALL INDIA COORDINATED RESEARCH PROJECT (ICAR)

ON

POST-HARVEST ENGINEERING AND TECHNOLOGY

JUNAGADH CENTRE

To be presented
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13-15 February, 2024

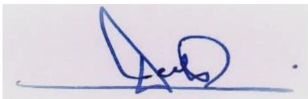
AICRP on Post-Harvest Engineering and Technology
Department of Processing and Food Engineering
College of Agricultural Engineering & Technology
Junagadh Agricultural University
JUNAGADH – 362001

ACKNOWLEDGEMENT

The All India Coordinated Research Project on Post-Harvest Engineering and Technology staff wish to communicae to their frank gratitude to Dr. V. P. Chovatiya, Vice Chancellor Junagadh Agricultural University, Junagadh; for their highly support in the activities of the scheme. We here by express our earnest thanks to Dr. R. B. Madariya, Director of Research, for able monitoring of the scheme work and Sh. S. K. Jethani, Comptroller Junagadh Agricultural University, Junagadh for resolving financial matters speedily. We hereby affirmative our honest thanks to Dr. P. M. Chauhan, Principal & Dean, College of Agricultural Engineering & Technology, Junagadh for caring direction, thought provoking annotations and keen interest shown in the activities of the scheme.

The staff members of the scheme gratefully acknowledge the financial assistance received by ICAR to run the scheme absolutely. The constructive criticism and esteemed remark of Dr. S. N. Jha, Deputy Director General (Engineering) and Dr. K. Narsaih, Assistant Director General (PE) ICAR, New Delhi are gratefully recognized. We express our most earnest thanks to Dr. R. K. Vishwakarma, Project Coordinator, AICRP on Post-Harvest Engineering and Technology, Central Institute of Post-Harvest Engineering & Technology, Ludhiana for their inspiring guidance, coordination as well as their keen interest in the activities of the scheme.

We are also thankful to all the staff members of the Department of Processing and Food Engineering for their support and taking due interest in the activities of the scheme work.



February 29, 2024
Junagadh

(M. N. Dabhi)
Research Engineer
for Scheme Staff

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

ALL INDIA CO-ORDINATED RESEARCH PROJECT (ICAR)

ON

POST HARVEST ENGINEERING AND TECHNOLOGY SCHEME

JUNAGADH AGRICULTURAL UNIVERSITY

JUNAGADH CENTRE

GENERAL INFORMATION

1.	**Title of the scheme**	:	All India Co-ordinated Research Project (ICAR) on Post-Harvest Engineering and Technology
2.	**ICAR sanction No. & Date**	**:**	1(41)/PHT/2006/XI Plan/1010998, dtd. 21.3.2009 (PC letter No.)
3.	**Date of commencement**	**:**	April, 1980
4.	**Date of completion**	:	The scheme is sanctioned for the 12^{th} Five Year Plan
5.	**Sanctioned grant for the Year 2020-2021 for which this report is presented**	:	Rs**. 1,08,89,000**/- (ICAR+State)

6. Staff position in the scheme

Sr. No.	Designation	No. of posts			Name of the incumbent	Present Scale of pay	Date of joining / vacant
		S	F	V			
1.	Research Engineer	1	1	-	Dr. M. N. Dabhi	131400-217100	01.09.2016
2.	Asstt. Bio-Chemist	1	1	-	Vacant	57700-182400	31.03.2022
3.	Asstt. Entomologist	1	1	-	Prof. D. V. Khanpara	131400-217100	16.06.1922
4.	Asstt. Food Microbiologist	1	1	-	Prof. A.M. Joshi	68900-205500	18.02.2009
5.	Asstt. Res. Engineer (ASPE)	1	1	-	Prof. P. R. Davara	68900-205500	01.01.2011
6.	Asstt. Process Engr. (Testing & Eva.)	1	-	1	Vacant	57700-182400	23.07.2020
7.	Senior Tech. Asstt.	1	1	-	Er. H. R. Sojaliya	39900-126600	14.02.2012
8.	Investigator	1	1	-	Er. B. A. Karangiya	38090 (fixed)	08.06.2022
9.	Draftman (Mech.)	1	1	-	Shri R. V. Bokhiriya	31340 (fixed)	01.01.2021
10.	Craftman-I (Welder)	1	1	-	Shri V. S. Kava	25500-81100	01.11.2014
11.	Craftman-II (Fitter)	1	1	-	Shri N. V. Vora	19900-63200	28.12.2008
12.	Craftman-III (Tinsmith)	1	-	1	Vacant	19900-63200	1.07.2016
13.	Senior Mechanic	1	1	-	Shri A. P. Zezariya	29200-92300	26.07.2018

7. Expenditure Statement for the year 2022-2023 (Upto March, 2023)

Head-wise breakup of Receipts, Expenditure and Closing Balances for the financial year 2022-23 (ICAR share)
Period : 01-04-2022 to 31-03-2023

Sr. No.	Budget Head	Opening balance as on 01-04-2022 Rs.	Sanctioned grant received during the year 2022-23 Rs.	Revalidated amount of Unspent Balances as on 01-04-2022, Rs. (3)	Total grant released for the year 2022-23 Rs. (4+5)	Expenditure incurred for the councils share during the year 2022-23 Rs.	Grant surrendered during the year 2022-23 Rs.	Closing balance at the end of the year 2022-23 as on 31-03-2023 Rs. (6-7-8)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	Pay and Allowances	18,589.50	96,00,000.00	18,589.50	96,18,589.50	83,81,142.00	12,37,447.00	**0.50**
2	Travelling Allowance	20,000.00	80,000.00	20,000.00	1,00,000.00	46,616.25	-	**53,383.75**
3	Recurring Contingencies (Including HRD)	5,38,795.25	8,70,000.00	5,38,795.25	14,08,795.25	5,53,372.50	8,08,796.00	**46,626.75**
4	Non recurring contingencies	4,14,124.81	3,39,000.00	4,14,124.81	7,53,124.81	5,93,413.50	-	**1,59,711.31**
	Total, Rs.	**9,91,509.56**	**1,08,89,000.00**	**9,91,509.56**	**1,18,80,509.56**	**95,74,544.25**	**20,46,243.00**	**2,59,722.31**

8. Technical Programme

Sr. No.	Code No.	Title
1.	PH/JU/85/1	Establishment of Agro Processing Centre training and demonstration of technologies (Operational research project on Agro Processing Centres)
2.	PH/JU/2020/01	Standardization of process technology for preparation of peanut sauce and peanut wadi (Chunks).
3.	PH/JU/2023/01	Management of insect pest of storage wheat in bin by ozone.
4.	New Investigation - I	Valorization of onion waste product for reinforcement of starch based biodegradable plastic.
5.	New Investigation - II	Valorization of pulse processing industrial waste for RTE product.
6.	New Investigation - III	Development of protein enriched Ready-to-Eat extruded product ideal for fasting by supplementing defatted peanut flour.
7.	New Investigation – IV	Development of millet based extruded product supplemented with defatted peanut flour.
8.	New Investigation – V	Optimization of process parameters for protein extraction from defatted peanut flour through fermentation.

Investigation No-1

1.1 Scheme code No. : PH/JU/85/1

1.2 Title of Investigation: Establishment of Agro Processing Centre training and demonstration of technologies (Operational research project on Agro Processing Centres)

1.3 Name of Investigators: 1. Dr. M. N. Dabhi

2. Prof. P. R. Davara

1.4 Objectives

1. Survey of selected villages to identify the available agro-processing equipment.
2. To transfer the developed and improved agro-processing equipment to the selected village to give value added product.
3. To evaluate the techno-economic feasibility of the agro-processing centre.

1.5 Justification

Migration from the village to the cities not only disturbs the rural based economy but also causes a saturated and explosive urban population growth. The dire need of the hour is to prevent this migratory trend from villages to cities, so as to increase the activities concerned with farming thereby increase food production. This could be prevented by stabilizing industries in the proximity of the source of raw materials or near the vicinity of consumption catchment's area to avoid higher transportation cost. This will help the village to become self-sufficient in production, processing and consumption of raw materials produce by them. More job opportunities would also be created, resulting in more income generation.

1.6 Date of start: April – 2012

1.7 Date of completion: Continue

1.8 Past Work done

Major equipment installed at agro processing centres were used for their operational work. In this period, oil milling, spice milling, groundnut decorticating, groundnut threshing, cleaning and grading of wheat were taken up. The detailed operational performance data and expenditure incurred, income obtained along with profit / loss were determined.

1.9 Progress of work

Agro processing centers were visited for monitoring the progress made by the centers. Loej, Virol, and Tadka pipaliya centre has also deposited installment for the year 2020-21. The detailed operational performance data and expenditure incurred, income obtained along with profit / loss were determined and presented in Table: 1.1.

Table 1.1 : Operational performance and income from the processed products

Sr. N.	Activities	Raw material processed (kg)	Finished material produced (kg)	Expenditure incurred (Rs.)	Income (Rs.)	Net income (Rs.)
	Tadaka Pipaliya Agro Processing Centre					
1	Oil milling (groundnut)	9800 kg	-	24500 (@ 2.5 Rs./kg.)	49000 (@ 5Rs./kg.)	24500
2	Cleaning and grading of wheat,	5700 kg	-	-	5700 (@ 1 Rs/kg.)	5700
3	Groundnut decortication (manually)	-	_	_	720 (@ 20Rs/day x 2 nos.)	720
4	Sesame processing	410 kg	-	12300	24600	12300
5	Groundnut threshing	-	-	-	43200 (@600Rs./hr; Total 72 hrs.)	43200
6	Pulse mill	320 kg	-	640	3200	2560
7	Spice milling	440 kg	-	880	4400	3520
	Loej Agro Processing Centre					
1	Oil milling (groundnut)	80000 kg	-	200000 (@ 2.5 Rs./kg.)	400000 (@ 5 Rs./kg.)	200000
2	Cleaning and grading of wheat,	2000 kg	-	-	2000 (@ 1Rs./kg.)	2000
	Virol Agro Processing Centre					
1	Oil milling (groundnut)	19500 kg	-	48750 (@ 2.5 Rs./kg.)	97500 (@ 5 Rs./kg.)	48750
2	Cleaning and grading of wheat	3700kg	-	-	3700 (@ 1 Rs./kg.)	3700
3	Spice milling	1570 kg Chilly 420 kg turmeric 210 kg cumin Total 2200	-	6600	22000	15400

1.10 Conclusion:

Agro Processing Centres are running very well for utilization of processing machinery and processing of farmers produce at village level.

1.11 Future plan of work

The experiment will be continued.

UPSCALE RESEARCH PROJECT - 1

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

RESEARCH PROJECT PROFORMA FOR UPSCALE OF RESEARCH OUTPUT to THE END USER (RPP- IV)

1. Institute Project Code : PH/JU/2018/02

2. Project Title : Standardization of process technology for preparation of peanut sauce and peanut wadi (Chunks) (for peanut sauce).

3. (a) Name of the Lead Institute : College of Agril. Engg. & Technology
(b) Name of Division/ Regional Center/ Section : AICRP on PHET, Junagadh

4. (a) Name of the Collaborating Institute(s) :
(b) Name of Division/ Regional Center/ Section of Collaborating Institute(s) :

5. Project Team(Name(s) and designation of PI, CC-PI and all project Co-PIs, with time spent)

Sr. No.	Name, designation and institute	Status in the project (PI/CC-PI/ Co-PI)
1.	Dr. P. R. Davara, Assistant Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	PI
2.	Prof. A. M. Joshi Assistant Microbiologist, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	Co-PI-I
3.	Dr. M. N. Dabhi, Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	Co-PI-II
4.	Dr. P. J. Rathod Assistant Biochemist, AICRP on PHET, Dept. of Bio-Technology, JAU, Junagadh	Co-PI-III

6. Details of Research Outputs

a. Details of research output (Product, Process, Technology, Methods, Tools, Software etc.) developed (Crop-based; Animal-based, including vaccines; Biological – biofertilizer, biopesticide, etc; IT based – database, software; Any other – please specify)

   - Crop-based Process technology developed

b. Intellectual Property Generated

   i. Patents - filed/obtained; Patent application is under progress
   ii. Copyrights- filed/obtained; -
   iii. Designs- filed/obtained; -
   iv. Registration details of variety/germplasm/accession, if any

c. Publications

   i. Research Papers : 1
   ii. Reports/Manuals : -
   iii. Working and Concept Papers :-
   iv. Popular Articles :-
   v. Books/Book Chapters : -
   vi. Extension Bulletins :-

7. Efforts made for commercialization of Research Output/ Technology transfer (with reference to item 15 of RPP - III)

Enumerate the efforts made for commercialization of research output/ technology transfer. The list of the activities executed like organization of awareness programmes may also be given.

Sr. No.	Details of the research output	Expected end users	Efforts made for transfer of research output to clientele	Outcome of the efforts
1.	Process technology is developed for the production of peanut sauce	Peanut processors	Mr. Nileshbhai, MD, Wellcrop Biotech Ltd., Morbi, manufacture for fermentation plant was contacted for development of pilot scale plant for the production of peanut sauce through fermentation method.   **Plate 2.1 : Discussion with Mr. Nileshbhai, MD, Wellcrop Biotech Ltd., Morbi** - Discussed the different aspects of peanut sauce production process. - Following facilities are to be developed for set up of pilot scale plant for peanut sauce production 1) Roaster (gas)	- Required facilities & plant layout is finalised in consultation with the manufacturer

2) Production fermenter - 1500 lit with automation control

3) 500 lit fermenter with automation

4) Skada automation

5) Connection and lining fitting

6) Boiler 1000 kg

7) Compressor- 30 Hp (IR made)

8) Dryer - IR made

9) Tank - local made

10) Filter unit 1micron - IR made

11) Cooling tower - small

12) Chiller - 1 no

13) Filter press - 1 no

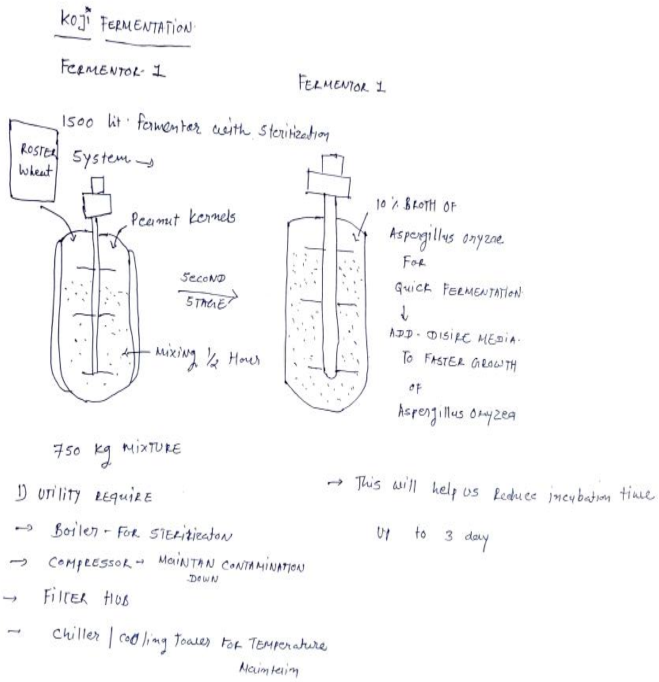
14) Continuous centrifuge - 1 no

15) Final production collection tank- 1no

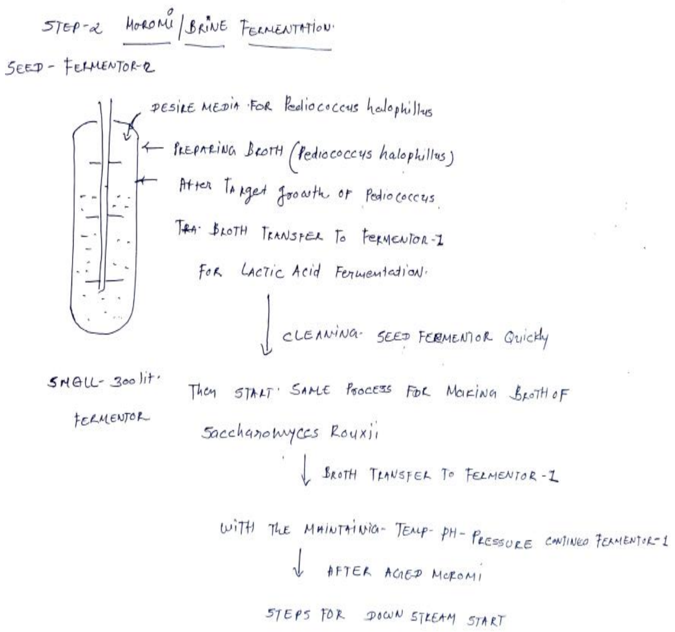
16) Filling machine manual - 1 no

-Lay out of facilities is as under

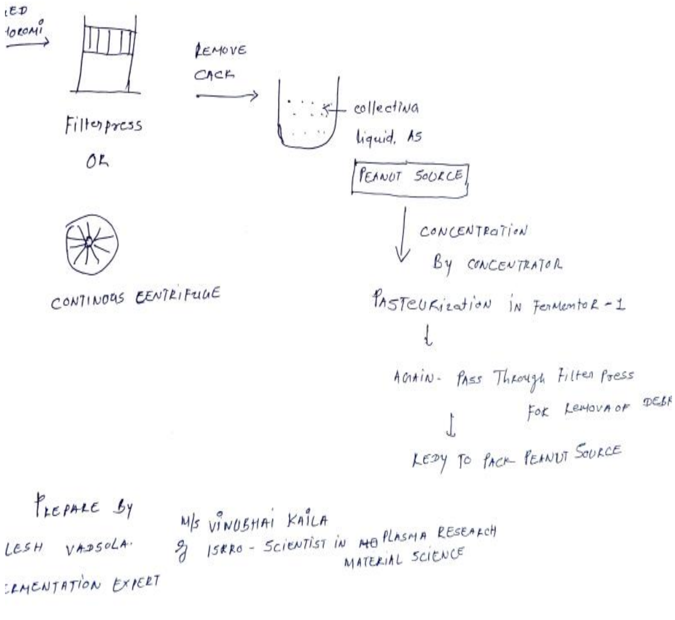
A. Koji Fermentation



B. Moromi Fermentation



C. Refining process



- According to plant manufacturer, small capacity plant will not provide enough working space in production and therefore it is neither technically feasible nor economically viable for fermentation process and it will take considerable time for required fermentation. According to him, minimum

			1500 lit capacity main fermenter & 500 lit 2nd fermenter tank is required for speed up the fermentation process. - Estimated cost for the above plant is about 1 crore. - Establishment of pilot scale plant will be commenced upon availability of the grant.	

8. Economic Benefits and Impact (with reference to those identified under item 14 of RPP - I and item 16 of RPP - III) - The samples of the developed peanut sauce was presented to the visiting entrepreneurs as well as students of the college. Further, the effort will be made to provide the training and literature of the developed process technology to the entrepreneurs and farmers for transfer of the developed technology.

9. Research work undertaken on the problems identified as future line of research work – Nil

10. Signature of PI, CC-PI(s), all Co-PIs

11. Signature of Head of Division

12. Observations of PME Cell

13. Signature of JD (R)/ Director

ONGOING INVESTIGATION – I

ANNEXURE - V

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

RESEARCH PROJECT PROFORMA FOR MONITORING ANNUAL PROGRESS (RPP- II)

(Refer for Guidelines ANNEXURE-XI (E))

1. Institute Project Code : PH/JU/2018/02

2. Project Title : Standardization of process technology for preparation of peanut sauce and peanut wadi (Chunks) (for peanut wadi).

3. Reporting Period : 01-02-2023 to 29-02-2024

4. Project Duration: Date of Start – 01-02-2020
Likely Date of Completion – 29-02-2024

5. Project Team (Name(s) and designation of PI, CC-PI and all project Co-PIs, (with time spent for the project) if any additions / deletions

Sr. No.	Name, designation and institute	Status in the project (PI/CC-PI/ Co-PI)	Time to be spent (%)	Work components to be assigned to individual scientist
1.	Dr. P. R. Davara, Assistant Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	PI	60%	1. Review collection/literature survey 2. Designing of the experiment 3. Procurement of raw materials 4. Procurement of microbial cultures and chemicals required to conduct the research trials 5. Quality analysis of the raw materials 6. Preliminary trials for production of peanut sauce and peanut wadi 7. Final trials for development of peanut sauce and peanut wadi using defatted peanut flour/kernels as per the different treatments 8. Physico-chemical and sensory analysis of the products 9. Data collection and its analysis 10. Optimization of process parameters based on the experimental data 11. Report writing
2.	Prof. A. M. Joshi Assistant Microbiologist, AICRP on PHET,	Co-PI-I	15%	1. To assist the PI during fermentation process for peanut sauce

	Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh			2. To assist the PI to carry out the microbiological analysis of the peanut sauce
3.	Dr. P. J. Rathod Assistant Biochemist, AICRP on PHET, Dept. of Bio-Technology, JAU, Junagadh	Co-PI-II	15%	1. To assist the PI to carry out biochemical analysis of the product
4.	Dr. M. N. Dabhi, Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	Co-PI-III	10%	To assist the PI in taking administrative approvals as and when needed to carry out the different project related activities

6. (a) Activities and outputs earmarked for the year (as per activities schedule given in RPP-I)

Objective wise	Activity	Scientist responsible	% of activity envisaged to be completed as per RPP-I	% achieved as targeted
1. To develop a process technology for preparation of peanut sauce and peanut wadi.	1. Review collection / literature survey	Dr. P. R. Davara	100%	100%
	2. Designing of the experiment	Dr. P. R. Davara	100%	100%
	3. Procurement of raw materials	Dr. P. R. Davara Dr. M. N. Dabhi	100%	100%
	4. Procurement of microbial cultures and chemicals required to conduct the research trials	Dr. P. R. Davara Prof. A. M. Joshi Dr. M. N. Dabhi	100%	100%
	5. Quality analysis of the raw materials	Dr. P. R. Davara	100%	100%
	6. Preliminary trials for production of peanut sauce and peanut wadi	Dr. P. R. Davara Prof. A. M. Joshi	100%	100%

	7. Final trials for development of peanut sauce and peanut wadi using defatted peanut flour/kernels as per the different treatments	Dr. P. R. Davara Prof. A. M. Joshi	100%	100%
2. To study the effect of process parameters on different quality and sensory parameters of peanut sauce and peanut wadi	1. Physico-chemical and sensory analysis of the developed products 2. Microbilogical analysis of the peanut sauce	Dr. P. R. Davara Dr. P. J. Rathod Prof. A. M. Joshi	100%	100% for peanut sauce & 10% for peanut wadi
3. To standardize the process parameters for preparation of peanut sauce and peanut wadi	1. Data collection and its analysis 2. Optimization of process parameters based on the experimental data	Dr. P. R. Davara Dr. M. N. Dabhi	100%	100% for peanut sauce & 10% for peanut wadi

(b) If shortfall/addition, reasons for the same and how to catch up with the intended activities

7. Annual Progress Report (research results and achievements in bullets)

A. Process technology for Peanut Sauce production

- Process technology for the production of peanut sauce either through Chemical method and Fermentation method is successfully developed and RPP-III is already presented during 38th Workshop held at Kasargod and it is approved.
- RPP-IV is submitted separately for the establishment of pilot scale plant for the production of peanut sauce. Plant will be established in the department upon availability of the grant.

B. Process technology for Peanut Wadi production

- Number of trials were conducted for the preparation of peanut wadi using the Twin Screw Extruder (Made : BTPL, Kolkata).
- Due to high moisture of defatted peanut flour it was converted into dough and lost its ability to free flow in the machine. As a consequence, there was an issue with feeding of raw material in the extruder machine.
- Further, the facility to add the moisture in the raw material after the material is fed in the machine is not working properly. Hence, the feeding of raw material and addition of moisture simultaneously is not possible in the machine.
- In some trials, the required texture in the peanut wadi could not be developed.
- In conclusion, the Twin Screw Extruder available in the department is not suitable to develop the texturized peanut wadi.

- As per the suggestion during 38th AICRP workshop, we have approached CIPHET to develop the peanut wadi using the Soy Wadi machine developed by CIPHET. But, the said machine is not working on an extrusion technology. Hence this machine is not capable to texturize the peanut protein and found to be not suitable for the manufacturing of Peanut wadi with textured protein.
- One manufacturer of soy *wadi* at Surat, Gujarat contacted for the production of peanut wadi. But, the minimum raw material required per batch/trial is about 50 kg as per the capacity of the machine and large quantity of peanut flour may be required for conducting the whole experiment. Hence, conducting the different treatments/research trials using commercial machine practically not feasible.
- Looking to above difficulties, the research work on peanut wadi could not be completed.

8. Output During Period Under Report

a. Special attainments/innovations

b. List of Publications (one copy each to be submitted with RPP-II)

   i. Research papers - 1

   ii. Reports/Manuals - Nil

   iii. Working and Concept Papers - Nil

   iv. Popular articles - Nil

   v. Books/Book Chapters - Nil

   vi. Extension Bulletins - Nil

c. Intellectual Property Generation
(Patents - filed/obtained; Copyrights- filed/obtained; Designs- filed/obtained; Registration details of variety/germplasm/accession if any) – Patent application is under progress

d. Presentation in Workshop/Seminars/Symposia/Conferences
(relevant to the project in which scientists have participated)

e. Details of technology developed
(Crop-based; Animal-based, including vaccines; Biological – biofertilizer, biopesticide, etc; IT based – database, software; Any other – please specify) - Crop-based Process technology developed

f. Trainings/demonstrations organized - Nil

g. Training received - Nil

h. Any other relevant information – Project is under progress

9. Constraints experienced, if any

- Due to non-availability of suitable technology or machine, the research work on peanut wadi production could not be completed. The difficulties face during the project work is explained in detail under point 7(B).

10. Lessons Learnt

- Nil

11. Evaluation

Self evaluation of the project for the period under report by the PI with rating in the scale of 1 to 10 — 8

(a) Evaluation by PI on the contribution of the team in the project including self

S. No.	Name	Status in the project (PI/CC-PI/Co-PI)	Rating in the scale of 1 to 10
1	Dr. P. R. Davara	PI	8
2	Prof. A. M. Joshi	Co-PI	8
3	Dr. P. J. Rathod	Co-PI	8
4	Dr. M. N. Dabhi	Co-PI	8

12. Signature of PI, CC-PI(s), all Co-PIs

13. Signature (with specific comments on progress/achievements, shortfall and constraints along with rating of the project in the scale of 1 to 10) of Head of Division/Regional Center / Section

14. Comments of IRC

15. Signature (with specific comments on progress/achievements, shortfall and constraints along with rating of the project in the scale of 1 to 10) of JD (R)/ Director

ONGOING INVESTIGATION – II

ANNEXURE - V

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

RESEARCH PROJECT PROFORMA FOR MONITORING ANNUAL PROGRESS (RPP- II)

(Refer for Guidelines ANNEXURE-XI (E))

1. Institute Project Code: PH/JU/2023/1
2. Project Title: Management of insect pest of storage wheat in bin by ozone.
3. Reporting Period: April 2023 to December 2023
4. Project Duration: Date of Start –April 2024 Likely Date of Completion –2025
5. Project Team (Name(s) and designation of PI, CC-PI and all project Co-PIs, (with time spent for the project) if any additions/deletions

Sr. No	Name, designation and institute	Status in the project (PI/CC-PI/ Co-PI)	Time spent (%)	Work components assigned to individual scientist
1.	Prof. D. V. Khanpara Assistant Entomology , AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., JunagadhAgril. University, Junagadh	PI	75%	1. Collected the review on insect pest stored wheat. 2. Fixed size of bin, selected the material quality of bin and decided manufacturer of bin 3. Fabricated bin and purchase 4. Procurement of good quality ozone machine 5. Checked bin about quality of materials, leakage of ozone and storage capacity of bin.
2.	Prof. A. M. Joshi Assistant Microbiologist, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., JunagadhAgril. University, Junagadh	Co-PI	15%	To assist the PI in all above aspects

3.	Dr. M. N. Dabhi, Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh.	Co-PI-II	10%	Supervision and Co-ordination

6. (a) Activities and outputs earmarked for the year (as per activities schedule given in RPP-I)

Objective wise	Activity	Scientist responsible	% of activity envisaged to be completed as per RPP-I	% achieved as targeted
1.	Fabrication of 20 GI metal cylindrical storage bins and purchase	Prof. D. V. Khanpara, Prof. A. M. Joshi, Dr. M. N. Dabhi	The bin is purchased according to new rules to purchase through GeM.	50%

(b) If shortfall/addition, reasons for the same and how to catch up with the intended activities

7. Annual Progress Report (research results and achievements in bullets)

As per the proceeding of the last year, we have purchased 20 GI metal cylindrical storage bins from the Rajkot centre. That was received by September 2023. In market, there was not available the bin as per our desire. We have contacted to different bin manufacturers. We convinced them to fabricate for 100 kg capacity bin. Accordingly, we have advertised in Newspaper and received hard copy of tenders. But due to new purchase policy we have to purchase it under GeM process. Accordingly, we have purchase 20 GI metal cylindrical storage bins.

Plate. 4.1 : Fabricated silo bin for 100 kg wheat capacity

8. Output during Period under Report

a. Special attainments/innovations

b. List of Publications (one copy each to be submitted with RPP-II)

ii. Research papers
iii. Reports/Manuals
iv. Working and Concept Papers
v. Popular articles
vi. Books/Book Chapters
vii. Extension Bulletins

c. Intellectual Property Generation

(Patents - filed/obtained; Copyrights- filed/obtained; Designs- filed/obtained; Registration details of variety/germplasm/accession if any)

d. Presentation in Workshop/Seminars/Symposia/Conferences

(Relevant to the project in which scientists have participated)

e. Details of technology developed

(Crop-based; Animal-based, including vaccines; Biological – biofertilizer, biopesticide, etc; IT based – database, software; Any other – please specify)

f. Trainings/demonstrations organized

g. Training received: Nil

i. Any other relevant information : Nil

9. Constraints experienced, if any: Nil

10. Lessons Learnt

11. Evaluation

(a) Self-evaluation of the project for the period under report by the PI with rating in the scale of 1 to 10 — 7

(b) Evaluation by PI on the contribution of the team in the project including self

Sr. No.	Name	Status in the project (PI/CC-PI/Co-PI)	Rating in the scale of 1 to 10
1	Prof. D. V. Khanpara	PI	7
2	Prof.A. M. Joshi	Co PI	7
3	Dr. M. N. Dabhi	Co PI	7

12. Signature of PI, CC-PI(s), all Co-PIs

13. Signature (with specific comments on progress/achievements, shortfall and constraints along with rating of the project in the scale of 1 to 10) of Head of Division/Regional Center / Section ☐

14. Comments of IRC

15. Signature (with specific comments on progress/achievements, shortfall and constraints along with rating of the project in the scale of 1 to 10) of JD (R)/ Director ☐

NEW INVESTIGATION – I

ANNEXURE - I

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
PROFORMA FOR PREPARATION OF STATUS REPORT
FOR PROPOSAL OF A NEW RESEARCH PROJECT

(Refer for Guidelines ANNEXURE-XI(A))

1. **Institute Name**: College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh

2. **Title of the project**: Valorization of onion waste product for reinforcement of starch based biodegradable plastic.

3. **Type of research project**: ~~Basic/~~Applied~~/Extension/Farmer Participatory/Other~~ (specify)

4. **Genesis and rationale of the project** :

Petrochemical based plastics films such as polyolefin, polyesters and polyamides have been increasingly used as packaging materials because of their availability in large quantities at low cost and functionality characteristics such as good tensile and tear strength, good barrier properties to oxygen and aroma compounds and heat seal ability. However, these plastics are made of petroleum based materials that are not readily biodegradable and therefore lead to environmental pollution, the most obvious form of pollution associated with plastic packaging is waste plastic dump to the landfills.

Under proper conditions, some biodegradable plastics can degrade to the point where microorganisms can completely metabolise them to carbon dioxide (and water). Biodegradable plastics can be composed of bio-plastics, which are plastics made from renewable raw materials. There are normally two forms of biodegradable plastic, injection molded and solid.

The actual tendency in packaging research is to develop and promote the use of "bio-plastics" which are useful in reducing waste disposal and are good replaces of petroleum, a non-renewable resource with diminishing quantities (Ruban, 2009; Souza et al., 2010). These biodegradable plasics should have good tensile and tear strength.

In order to overcome the weakness of pure starch-based materials, such as lower mechanical properties found in natural polymers and moisture sensitivity, various blends and composites have been developed in the last two decades. In practical, incorporation of any additives is sensitive in developing fully biodegradable starch-based materials. Furthermore, safety issues will be considered as priority regarding any additives for food packaging applications. Based on these concerns, various natural filler and edible reinforce agents, such as natural fibers, starch or cellulous crystals, and laver, have been used in starch-based materials. So-called self-reinforced techniques, reinforcing starch matrix by modified starch particles, have also been used in developing starch-based composites. During developing starch-based foams the unique function of water, acts as both plasticizer and blow agent for starch-based foam, has been systematically studied.

Large amount of onion waste is produced by consumption of onion both domestically and industrially, making it necessary to search for their utilization. The main onion waste include onion skins, two outer fleshy scales and roots generated during industrial peeling and undersized malformed or damaged bulbs.

5. Knowledge/Technology gaps and justification for taking up the present project including the questions to be answered

Starch is one of the most promising natural polymers because of its inherent biodegradability, overwhelming abundance and annual renewability. Starches offer a very attractive low cost base for new biodegradable polymers due to their low material cost and ability to be processed with conventional plastic processing equipment.

Reinforcement by fiber has been widely used in developing polymeric composites and has successfully proven their value due to their excellent specific properties, e.g. high strength and stiffness, and low weight. The composites reinforced by fiber have been widely reported and even reviewed by many authors previously. In aspect of biodegradable materials, natural fibers are of particular interest since they not only have the functional capability to substitute the widely applications, but they also have advantages, such as lower density, and fiber-matrix adhesion, specifically with polar natural matrixes, such as starches and proteins. The natural fibers have showed good potential for application in waste management due to their biodegradability and their much lower production of ash during incineration.

Starch reinforced by cellulose fiber is a typical example of natural polymer composites. The reinforced composites have the advantages of being renewable, biodegradable, abundantly available and inexpensive. Such composites have attracted great attention in the last two decades. Generally, improving mechanical properties is one of the major driving forces to reinforce starch based materials using cellulose fibers (Jiang et al. 2020).

Biotechnological processes are being developed as an alternative to existing route or to get new biodegradable biopolymers. This new material is called as a biodegradable "green plastic", which is derived from plants and microorganisms. Biodegradable plastics are those that can be completely degraded in landfills, composters or sewage treatment plants by the action of naturally occurring micro-organisms. Truly biodegradable plastics leave no toxic, visible or distinguishable residues following degradation (Mooney et al., 2009).

Today the use of polymers from renewable sources in food packaging is growing (Mensitieri et al., 2011). To extend the shelf-life of all types of foods with increasing the preservation and protection from oxidation and microbial spoilage the tendency is to use more natural compounds. The use of synthetic films has led to big ecological problems because this materials are non-biodegradable (Sabiha-Hanim and Siti-Norsafurah, 2012). The natural biopolymers that are used in food packaging have the advantages to be available from replenishable resources, biocompatible, biodegradable, and all this characteristics led to ecological safety (Prashanth and Tharanathan, 2007). Polymers extracted or removed from natural resources can be degraded and transformed under different environmental conditions and under the action of different microorganisms (Mensitieri et al., 2011).

Polysaccharides such as starch, and cellulose, are natural polymers, called biopolymers, which are found in nature during the growth cycles of all organisms. Other natural polymers are the proteins which can be used to produce biodegradable materials. Whey protein are capable to form elastic films, and they have been employed as raw material for biodegradable packaging because they have good oxygen barrier and moderate moisture permeability (Shingala et al., 2019). This polymers are often chemically modified with the goal to modify the degradation rate and to improve the mechanical properties (Vroman and Tighzert, 2009).

Among the natural polymers, starch is of interest. It is regenerated from carbon dioxide and water by photosynthesis in plants. Owing to its complete biodegradability, low cost and renewability, starch is considered as a promising candidate for developing sustainable materials. Many efforts have been exerted to develop starch-based polymers for conserving the petrochemical resources, reducing environmental impact and searching more applications.

As the amylose content of starch increases, the elongation and strength increase too. The stability of starch under stress is not high. The glucoside links start to break at 150 °C and above 250 °C the granules collapse. Starch is usually used as a thermoplastic. It is plasticized in the presence of specific amounts of water or plasticizers and heat.

Cellulose nanocrystals can be isolated from onion skin and that can be successfully utilized a filler for the preparation of bionanocomposite films. These films had the highest tensile strength with lowest water vapour permeability.

6. Critical review of present status of the technology at national and international levels along with complete references :

Recently, several new natural fibers/fabrics were also utilized to extract the fibers for composite applications (Jayaramudu et al. 2009; Maheswari et al. 2008; Reddy et al. 2012). Among such new fiber sources, agricultural waste or agricultural processing by-product such as stalks from onion and garlic and their skins have high potential for the development of new source of natural fiber. The cellulose microfibers extracted from the stalks and skins of onion and garlic were more heat stable than their neat fibers. The result showed that the skin and stalk of onion and garlic have a high potential for the utilization as a new source of biopolymer resources (J. Prasad Reddy et al., 2018).

Reinforcing fillers such as filler for starch based edible films was analyzed by Psomiadou et al. (1996). The results showed higher strength and elongation and lower water vaour transmission rate of bioplastics. Microcrystalline cellulose is used as reinforcing filler that offers higher density of hydroxyl groups on its surface that is available for hydrogen bonding.

It was found that relative humidity and temperature play an important role in determining the water sorption and mechanical properties of starch and starch/CNP films. Thus, for food packaging application, it is vital to control both factors to ensure the efficiency of the films as an alternative food packaging material as both factors will determine the stability and shelf life of the films. This study proves that at certain relative humidity and temperature, addition of CNP into starch films was able to improve the water sorption and mechanical properties of the starch films. To reduce the water sorption and enhance mechanical properties hence increase stability and shelf life of the starch/CNP films, the films need to be kept at a low relative humidity and high temperature, but the temperature must not be extremely high (40°C) because addition of CNP was able to create a tortuouspathway within the film matrix and act as reinforcement at lower temperature of 4 and 30°C but not at 40°C due to the instability of the chitosan at extreme temperature. Sirwani (2021) worked on arranging jacket over the grinding chamber and circulating coolant through this jacket to reduce the temperature of the grinding chamber.

References :

1. Jeevan Prasad Reddy & Jong-Whan Rhim (2018): Extraction and Characterization of Cellulose Microfibers from Agricultural Wastes of Onion and Garlic, Journal of Natural Fibers, DOI: 10.1080/15440478.2014.945227.
2. Psomiadou E, Arvanitoyannis I, Yamamoto N 1997 Edible films made from natural resources; microcrystalline cellulose (MCC), methylcellulose (MC) and corn starch and polyols. Part 2. Carbohydr Polym 31 193–204.
3. Maulida, M Siagian, P Tarigan. 2016 J. Journal of Phys.: Conf. Ser. 710 012012. doi:10.1088/1742-6596/710/1/012012.

4. Jiang T, Duan Q, Zhu J, Liu H, Yu L. (2020). Starch based biodegradable materials:Challenges and Opprtunities. Advanced Industrial and Engineering Polymer Research. Vol. 3:8-18.
5. Othman S H, Kechik N R A, Shapi'i R A, Talib R A, Tawakkal I S M A. (2019). Water sorption and mechanical properties of starch/chitosan nanoparticle films. Journal of Nanomaterials. Volume 2019, Article ID 3843949, 12 pages. https://doi.org/10.1155/2019/3843949

7. Expertise available with the investigating group/Institute

The starch based plastic from potato starch, rice starch and corn starch is already experimented during PG experiment of Ph. D. Student. This is advance stage of this project. As the indirect starch based plastic has lower mechanical strength there is need to increase the strength of plastic film. Onion processing industries are available in this area and hence availability of onion waste is also available. The PI & Co-PI of project is having enough experience of working in the field of Processing and Food Engineering. Both are the experts in the field of Processing and Food Engineering. The PI is quite capable and qualified to handle this project. The facility and man power is available in the institute for fabrication of the machine and to conduct the operations in the laboratory.

8. Brief note on Proprietary/Patent Perspective (for projects related to technology development)/Ethics/Animal Welfare/Bio Safety Issues

- No issues are there on these aspects.

9. (a) **Expected output**

i. The existing starch based plastic film development process will be modified.
ii. The proposed technology will be economical and can be affordable.
iii. There will be increase in the mechanical strength hence use of this technology makes viability of the biodegradable plastic film.

(b) **Clientele/Stake holders (including economic and socio aspects)**

i. Biodegradable plastic film producer
ii. Packaging industries.

10. Signatures

[Project Leader] [Co-PIs] ……

11. **Comments and signature**

[Head of Division]

ANNEXURE- II

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

RESEARCH PROJECT PROFORMA FOR

INITIATION OF A RESEARCH PROJECT (RPP - I)

(Refer for Guidelines ANNEXURE-XI (B))

1. **Institute Project Code (to be provided by PME Cell)**
2. **Project Title:** Valorization of onion waste product for reinforcement of starch based biodegradable plastic.
3. **Key Words**: Onion waste, biodegradable plastic, starch, reinforcement
4. **(a) Name of the Lead Institute**: College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh

   (b) Name of Division/ Regional Center/ Section: AICRP on PHET, Junagadh centre
5. **(a) Name of the Collaborating Institute(s)** : --

   (b) Name of Division/ Regional Center/ Section of Collaborating Institute(s) : Department of Biochemistry, JAU, Junagadh.
6. **Project Team(Name(s) and designation of PI, CC-PI and all project Co-PIs, with time proposed to be spent)**

S. No.	Name, designation and institute	Status in the project (PI/CC-PI/ Co-PI)	Time to be spent (%)	Work components to be assigned to individual scientist
1.	Dr. M. N. Dabhi, Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh.	PI	60%	12. Development of low temperature grinder 13. Grinding of spices 14. Modifications in the low temperature grinder 15. Data collection and its analysis 16. Report writing
2.	Dr. P. R. Davara, Assistant Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	Co-PI	30%	To assist the PI in all above aspects

7. **Priority Area to which the project belongs** : Post Harvest Technology
(If not already in the priority area, give justification)

8. **Project Duration: Date of Start: 01-04-2024**
Likely Date of Completion: 31-03-2026

9. **(a) Objectives**
   1. Extraction of cellulose from onion skin.
   2. Development of starch based biodegradable plastic film.
   3. Reinforcement of starch based biodegradable plastic film.
   4. Testing of physical and mechanical properties of developed film.

(b) Practical utility

i. Valorize the onion industrial waste for better use.
ii. The existing starch based plastic films has poor mechanical strength which need to reinforcement.
iii. Biodegradable plastic producer will have better opportunity to develop better quality of biodegradable plastic film.

10. **Activities and outputs details**

Objective wise	Activity	Month & Year of		Output monitorable target(s)	% to be carried out in different years			Scientist(s) responsible
		Start	Completion		1	2	..	
1.	1. Extraction of cellulose from onion skin	April-24	Dec-24	To extract cellulose from onion skin	100%	--	--	Dr. M. N. Dabhi
	2. Development of starch based plastic reinforced with cellulose extracted from onion skin	Dec-24	Mar-24	To develop starch based plastic reinforced with cellulose extracted from onion skin with different proportion of binding material and reinforcement material.	100%	--	--	Dr. M. N. Dabhi, Dr. P. R. Davara,
2.	Testing of developed biodegradable film	Mar-24	June-24	Grinding of turmeric and cumin will be carried out and temperature profile will be prepared	50%	50 %	--	Dr. M. N. Dabhi Dr. P. R. Davara,

3.	Analysis of physical and mechanical properties	July-24	Dec-24	Physical and mechanical properties analysis will be carried out using appropriate technology of texture analzer	50%	50 %	- -	Dr. M. N. Dabhi
4.	Report writing	Jan-25	Marc-25	Compilation of collected data and preparation of report	--	100%	- -	Dr. M. N. Dabhi

Work Plan/Activity Chart

2024									2023												2024		
Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Extraction of cellulose from onion skin																							
								Development of starch based plastic reinforced with cellulose extracted from onion skin															
											Testing of developed biodegradable film												
															Analysis of physical and mechanical properties								
																					Report writing		

11. **Technical Programme (brief)**

Justification :

Starch is one of the most promising natural polymers because of its inherent biodegradability, overwhelming abundance and annual renewability. Starches offer a very attractive low cost base for new biodegradable polymers due to their low material cost and ability to be processed with conventional plastic processing equipment. Reinforcement by fiber has been widely used in developing polymeric composites and has successfully proven their value due to their excellent specific properties, e.g. high strength and stiffness, and low weight. The composites reinforced by fiber have been widely reported and even reviewed by many authors previously. In aspect of biodegradable materials, natural fibers are of particular interest since they not only have the functional capability to substitute the widely applications, but they also have advantages, such as lower density, and fiber-matrix adhesion, specifically with polar natural matrixes, such as starches and proteins. The natural fibers have showed good potential for application in waste management due to their biodegradability and their much lower production of ash during incineration. Starch reinforced by cellulose fiber is a typical example of natural polymer composites. The reinforced composites have the advantages of being renewable, biodegradable, abundantly available and inexpensive. Such composites have attracted great attention in the last two decades. Generally, improving mechanical properties is one of the major driving forces to reinforce starch based materials using cellulose fibers (Jiang et al. 2020). Biotechnological processes are being developed as an alternative to existing route or to get new biodegradable biopolymers. This new material is called as a biodegradable "green plastic", which is derived from plants and microorganisms. Biodegradable plastics are those that can be completely degraded in landfills, composters or sewage treatment plants by the action of naturally occurring micro-organisms. Truly biodegradable plastics leave no toxic, visible or distinguishable residues following degradation (Mooney et al., 2009). Today the use of polymers from renewable sources in food packaging is growing (Mensitieri et al., 2011). To extend the shelf-life of all types of foods with increasing the preservation and protection from oxidation and microbial spoilage the tendency is to use more natural compounds. The use of synthetic films has led to big ecological problems because this materials are non-biodegradable (Sabiha-Hanim and Siti-Norsafurah, 2012). The natural biopolymers that are used in food packaging have the advantages to be available from replenishable resources, biocompatible, biodegradable, and all this characteristics led to ecological safety (Prashanth and Tharanathan, 2007). Polymers extracted or removed from natural resources can be degraded and transformed under different environmental conditions and under the action of different microorganisms (Mensitieri et al., 2011). Polysaccharides such as starch, and cellulose, are natural polymers, called biopolymers, which are found in nature during the growth cycles of all organisms. Other natural polymers are the proteins which can be used to produce biodegradable materials. Whey protein are capable to form elastic films, and they have been employed as raw material for biodegradable packaging because they have good oxygen barrier and moderate moisture permeability (Shingala et al., 2019). This polymers are often chemically modified with the goal to modify the degradation rate and to improve the mechanical properties (Vroman and Tighzert, 2009). Among the natural polymers, starch is of interest. It is regenerated from carbon dioxide and water by photosynthesis in plants. Owing to its complete biodegradability, low cost and renewability, starch is considered as a promising candidate for developing sustainable materials. Many efforts have been exerted to develop starch-based polymers for conserving the petrochemical resources, reducing environmental impact and searching more applications. As the amylose content of starch increases, the elongation and strength increase too. The stability of starch under stress is not high. The glucoside links start to break at 150 °C and above 250 °C the granules collapse. Starch is usually used as a thermoplastic. It is plasticized in the presence of specific amounts of water or plasticizers and heat. Cellulose nanocrystals can be isolated from onion skin and that can be successfully utilized a filler for the preparation of bionanocomposite films. These films had the highest tensile strength with lowest water vapour permeability.

Various lignocellulosic resources generated from agricultural or food processing industries have been used for the isolation of cellulose nanofibers or whiskers to test their potential use for the preparation of biocomposite (Yu et al. 2006). Alemdar and Sain. (2008) extracted cellulose nanofibers from the agricultural residues such as wheat straw and soy hulls by using chemical and mechanical methods to test their potential use as reinforcement fibers in biocomposite formation. Oksman et al. (2011) extracted cellulose nanowhiskers from industrial bio-residues as a source of raw material. Santos et al. (2013) isolated cellulose nanowhiskers from an annually renewable agricultural residue pineapple leaf.

As one of underutilized lignocellulose sources, onion skins are interesting since they are abundantly produced in the food processing industry as a waste or by-product. Onion skins are outer layers of onion bulb which are peeled off and discarded as waste in the food processing industry. Although onion skins are rich in functional ingredients including fibers and functional phenolic compounds such as quercetin and other flavonoids (Benı´tez et al. 2011), only a limited number of efforts have been attempted to exploit the material for the industrial use.

Considerable research efforts have been focused on the development of completely biodegradable composite materials by blending cellulose nanofibers with bioplastics such as PLA and PHBV (Huda et al. 2008; Singh et al. 2008; Suryanegara et al. 2009; Nyambo et al. 2010). As one of such biopolymers, potato starch has been considered as a good candidate for the preparation of bionanocomposite since it is abundantly available and renewable biopolymer with excellent film forming property, biodegradability, and biocompatibility.

Therefore, the main objectives of the present study is to isolate cellulose microfibers from industrial onion waste and to prepare composite film by blending the cellulose microfiber with potato starch for the value-added utilization of onion skin.

Objectives

1. Extraction of cellulose microfibers from onion skin.
2. Development of starch based biodegradable plastic film with cellulose microfibers.
3. Testing of physical, physicochemical and mechanical properties of developed film.

Technical programme

1. Collection of onion skin from industries.
2. Extraction of cellulose microfibers from onion skin.
3. Development of starch based biodegradable plastic film with cellulose microfibers extracted from onion skin.
4. Physical and mechanical properties testing of developed biodegradable plastic film.

Methodology:

Onion skin will be collected from the onion dehydration industrial waste. The cellulose microfiller will be extracted by the process.....

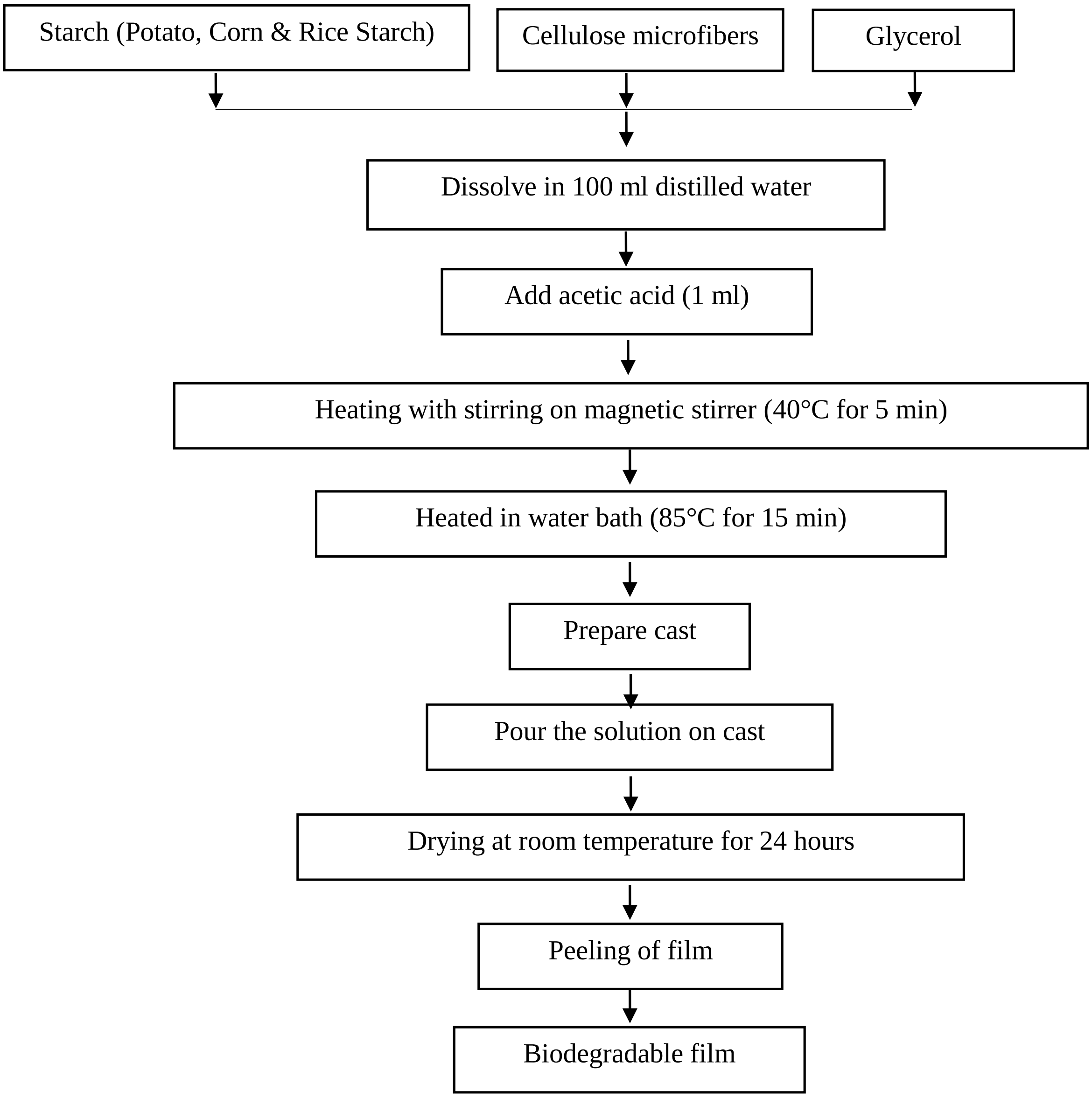


Fig. 5.1 : Process flow chart for formation of starch based reinforced biodegradable film

Treatment details :

Independent variable

1	First factor	:	Starch Concentration (Potato, Corn and Rice starch individual) (5, 6.5, 8, 9.5 & 11 % (W/V))
2	Second factor	:	Glycerol Concentration (0.5, 0.875, 1.25. 1.625 & 2 % (V/V))
3	Third factor	:	Cellulose microfiber (0.05%, 0.10, 0.15%, 0.20%, 0.25% (W/V))
4	Experimental design	:	Central Composite Rotatable Design (Response Surface Methodology)

Dependent variables

1. Moisture content, %
2. Tensile strength, MPa
3. Puncture strength, MPa
4. Water absorption capacity, %
5. Water vapour permeability, g/Pa hr.m
6. Transparency, %

Observations to be recorded

Physical properties of potato starch powder:

i. Water absorption ii. Water solubility index

Physical properties of developed biodegradable plastic film:

i. Thickness,

Physico-chemical properties of developed starch based biodegradable plastic films:

i. Moisture content, ii. Transparency,

iii. Water absorption capacity, iv. Water vapour permeability and

v. Surface morphology,

Mechanical properties of developed starch based biodegradable plastic films:

i. Tensile strength ii. Puncture strength and

Biodegradation properties of developed starch based biodegradable plastic films:

i. Reduction in weight ii. Rate of biodegradation

<u>Possible outputs</u> :

- The onion dehydration industrial waste will be utilized to prepare reinforced biodegradable plastic film.

References:

1. Jeevan Prasad Reddy & Jong-Whan Rhim (2018): Extraction and Characterization of Cellulose Microfibers from Agricultural Wastes of Onion and Garlic, Journal of Natural Fibers, DOI: 10.1080/15440478.2014.945227.
2. Psomiadou E, Arvanitoyannis I, Yamamoto N 1997 Edible films made from natural resources; microcrystalline cellulose (MCC), methylcellulose (MC) and corn starch and polyols. Part 2. Carbohydr Polym 31 193–204.
3. Maulida, M Siagian, P Tarigan. 2016 J. Journal of Phys.: Conf. Ser. 710 012012. doi:10.1088/1742-6596/710/1/012012.
4. Jiang T, Duan Q, Zhu J, Liu H, Yu L. (2020). Starch based biodegradable materials:Challenges and Opprtunities. Advanced Industrial and Engineering Polymer Research. Vol. 3:8-18.
5. Othman S H, Kechik N R A, Shapi'i R A, Talib R A, Tawakkal I S M A. (2019). Water sorption and mechanical properties of starch/chitosan nanoparticle films. Journal of Nanomaterials. Volume 2019, Article ID 3843949, 12 pages..

12. **Financial Implications (` in Lakhs) : Rs. 32.92 lakhs**

(A) Financed by the institute

12.1 **Manpower (Salaries / Wages)**

Sr. No.	Staff Category	Man months	Cost
1.	Scientific	18	30,00,000
2.	Technical	--	--
3.	Supporting	--	--
4.	SRFs/RAs	--	--
5.	Contractual	18	180000
	Total	36	31,80,000

12.2 **Research/Recurring Contingency**

Sr. No.	Item	Year(1)	Year (2)	Year (3)	Total
1.	Consumables	25000	10000	--	35000
2.	Travel	5000	--	--	5000
3.	Field Preparation/ Planting/ Harvesting (Man-days/costs)	--	--	--	--
4.	Inter-cultivation & Dressing (Man-days/costs)	--	--	--	--
5.	Animal/Green house/Computer Systems/Machinery Maintenance	5000	--	--	5000
6.	Miscellaneous(Other costs)	5000	--	--	5000
	Total(Recurring)	40000	10000	--	50000

Justification : ---

12.3 **Non-recurring (Equipment)**

S. No.	Item	Year (1)	Year (2)	Year (3)…	Total
1.	--	--	--	--	--
	--	--	--	--	--

Justification : ---

12.4 **Any Other Special Facility required (including cost)**

12.5 **Grand Total (12.1 to 12.4)**

Item	Year (1)	Year (2)	Year (3)	Total
Grand Total	20,40,000	10,10,000	--	30,50,000

(B) **Financed by an organization other than the Institute (if applicable)** : No

(i) Name of Financing Organization : NA

(ii) Total Budget of the Project : --

(iii) Budget details

Sr. No.	**Item**	**Year(1)**	**Year(2)**	**Year (3)**	**Total**
1	Recurring Contingency				
	Travelling Allowance	--	--	--	--
	Workshops	--	--	--	--
	Contractual Services/ Salaries	--	--	--	--
	Operational Cost	--	--	--	--
	Consumables	--	--	--	--
2	Non - Recurring Contingency				
	Equipment	--	--	--	--
	Furniture	--	--	--	--
	Vehicle	--	--	--	--
	Others (Miscellaneous)	--	--	--	--
3	HRD Component				
	Training	--	--	--	--
	Consultancy	--	--	--	--
4	Works (i) New (ii) Renovation	--	--	--	--
5	Institutional Charges				

13. **Expected Output:** New technology for reinforced biodegradable plastic will be available.

14. **Expected Benefits and Economic Impact**
    - The onion dehydration industrial waste will be utilized to prepare reinforced biodegradable plastic film.
15. **Risk Analysis**
16. **Signature**

    Project Leader Co-PI-I Co-PI-II
17. **Signature of HoD**
18. **Signature of JD (R) / Director**

ANNEXURE - III

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

CHECKLIST FOR SUBMISSION OF RPP-I

(Refer for Guidelines ANNEXURE-XI(C))

1. **Project Title** : Valorization of onion waste product for reinforcement of starch based biodegradable plastic.

2. **Date of Start & Duration** : Date of Start: 01-04-2024

   Likely Date of Completion : 31-03-2026

3. **Institute Project** [√] or Externally Funded [ ]

4. **Estimated Cost of the Project** : 30.50 lakh

5. **Project Presented in the Divisional/Institutional Seminar?** ~~Yes~~ / No

6. **Have suggested modifications incorporated?** ~~Yes~~ / No

7. **Status Report enclosed** Yes / ~~No~~

8. **Details of work load of investigators in approved ongoing projects**:

Project Leader				Co-PI – I				Co-PI – II…
Proj. Code.	% Time spent	Date of start	Date of compl-etion	Proj. Code.	% Time spent	Date of start	Date of completion	………
-	-	-	-	-	-	-	-	

9. **Work Plan/Activity Chart enclosed** Yes / ~~No~~

10. **Included in Institute Plan Activity** Yes / ~~No~~

11. **Any previous Institute/Adhoc/Foreign aided projects on similar lines?** ~~Yes~~ / No

12. **New equipment required for the project** ~~Yes~~ / No

13. **Funds available for new equipment** ~~Yes~~ / No

14. **Signatures**

Project Leader Co-PI-I Co-PI-II Co-PI–n

HOD/PD/I/c

ANNEXURE - IV

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

APPRAISAL BY THE PME CELL OF RPP-I

(Refer for Guidelines ANNEXURE-XI (D))

1. **Institute Name**
2. **Project Title**
3. **On scale 1-10 give score to (a) to (j)**

(a)	Relevance of research questions	☐
(b)	Addressing priority of the institute and/or National priority	☐
(c)	New innovativeness expected in the study	☐
(d)	Appropriateness of design/techniques for the questions to be answered	☐
(e)	Elements of bias addressed in the study	☐
(f)	Adequacy of scientist(s) time allocation	☐
(g)	Extent of system review and meta analysis	☐
(h)	Effective control to experiments	☐
(i)	Economic evaluation and cost efficiency analysis	☐
(j)	How appropriately the expected output answers the questions being addressed in the specific subject matter/area (Basic/Applied/Translational/Others)?	☐
	***Total Score out of 100**	

* The score obtained is suggestive of the overall quality ranking of the project

4. **Was there any other project carried in the past in the same area/topic?**

Yes ☐ No ☐

If yes, list the project numbers.

5. **Signature of PME Cell Incharge**

NEW INVESTIGATION – II

ANNEXURE - I

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

PROFORMA FOR PREPARATION OF STATUS REPORT FOR PROPOSAL OF A NEW RESEARCH PROJECT

(Refer for Guidelines ANNEXURE-XI(A))

1. **Institute Name :** College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh
2. **Title of the project :** Valorization of pulse processing industrial waste for RTE product.
3. **Type of research project :** ~~Basic~~/Applied~~/Extension/Farmer Participatory/Other~~ (specify)

4. Genesis and rationale of the project :

The increasing amount of time spent away from home has led to an increase in snacking. Consumers nowadays are becoming more and more aware of the concept of convenience and healthy RTE foods. Owing to the changes in the life styles, economic status and health issues, foods are expected to meet many challenges in life. People are moving towards foods that not only prevent nutritional deficiency but also offer long term prevention from chronic diseases. Expanded products like snacks and breakfast pulses are very popular today because of their taste and texture. Extrusion is an ideal process that is used to make a wide range of snack and breakfast pulses products.

5. Knowledge/Technology gaps and justification for taking up the present project including the questions to be answered :

India is one of the major pulses growing country of the world, accounting roughly for one third of total area under pulses cultivation and one fourth of total world production. Pulses occupy a key position in Indian diet and meet about 30% of the daily protein requirement. Among different countries producing pulses, India ranks first by contributing about 25.77 % to the global pulse production (FAO, 2011). Pulses are a valuable source of proteins, minerals and vitamins in the daily diets of the people. Pigeon pea (Cajanus cajan L.) is one of the important pulse crops of India contributing 20.87 % to the total production of all pulses. India accounts for 90 % of the total world production of pigeon pea (Goyal et al., 2008). In large scale processing of pigeon pea, the per cent loss of cotyledon in terms of powder and broken grain is as high as 12.8 % and 4.4 %, respectively (Singh, 1995). In view of this, when considering 10 % on an average milling loss of pigeon pea, it amounts to 2.7 lakh tonnes for all India with a value of ₹ 675 crores on dhal basis (Patel *et al.,* 2001). Utilization of the milling loss is an important.

Revolution in living standard and eating habits has opened vast market for snacks food. Extrusion is one such method, through which low-cost nutritious food products could be produced. Extrusion cooking is a high-temperature short-time (HTST) processing technology which offers several advantages over other types of cooking process. The retention of nutrients during extrusion process is better than other cooking processes due to the lower processing time.

6. **Critical review of present status of the technology at national and international levels along with complete references :**

Pearl millet is termed as a Nutri-cereal because of its excellent nutritional profile compared to other cereals. The energy of this millet (361 kcal/100 g) is greater than sorghum and nearly equal to that of brown rice because the lipid content is generally higher (Nambiar et al., 2011).

The pigeon pea grain is considered as most difficult for de-hulling as compared to other pulses owing to its seed coat which is more firmly attached with the cotyledons through a layer of gum and mucilage (Rout *et al.*, 2007). Due to the presence of gummy layer and hard seed coat, it is difficult to de-hull. The primary objective of de-hulling is to remove seed coat from the cotyledons, during which four different fractions, i.e., dhal, broken, powder and husk are obtained. In the process of de-hulling, noticeable amount of cotyledon material and germ are removed resulting into considerable loss. In large scale processing of pigeon pea, the per cent loss of cotyledon in terms of powder and broken grain is as high as 12.8 % and 4.4 %, respectively (Singh, 1995).

Naghera and Dabhi (2023) developed the extruded RTE product using pearl millet and chick pea. The optimized extrusion variables were a die temperature of 138 °C, a screw speed of 320 rpm, and a feed moisture content of 14.5% (w.b.). These results were bulk density as 43.92 kg/m3, true density as 298.53 kg/m3, expansion ratio as 4.07, water solubility index as 22.96 %, water absorption index as 5.31 g/g, water holding capacity as 514.83 %, hardness as 27.33 N, moisture content as 5.12 %, true protein as 5.59 %, calcium as 289.24 ppm, and sensory score as 8.19.

Chakraborty et al. (2009) studied the extrusion cooking of five blends of millets and legume pieces (viz. 12, 16, 20, 24, 28% legume pieces) at varying moisture contents (12, 15, 18, 21, 24% w.b.). The optimum processing conditions were obtained moisture content 24%, w.b., blend ratio 18.7% legume pieces, die head temperature 171.20 °C, barrel temperature 140 °C and screw speed 103.8 rpm. The corresponding textural properties of the extrudates in terms of crispness, hardness and cutting strength were 50, 48.2 and 79.7 N, respectively.

Devi et al. (2013) investigated the effect of incorporation of protein sources such as whey protein isolate, defatted soy flour and mixed legume flour, to the sorghum/corn flour blends at 30%. A 50:50 blend of defatted soy flour and whey protein isolate was also added at 30% to the sorghum/corn flour blends. The resultant formulations were undergone through extrusion and were evaluated for the effects of sorghum/corn flour ratio and protein addition on product expansion, microstructure, mechanical properties and sensory attributes. Higher corn flour level increased the product expansion, which decreased due to incorporation of protein sources. Soy flour added extrudates show a lower expansion ratio (5.3 - 5.4), as compared to that of whey protein isolate (7.7 - 7.9), legume flour (7.1 - 9.9), or whey protein isolate defatted soy flour (6.1 - 6.9). Average crushing force (ranging from 40.9 to 154.87 N) was lower for extrudates with a higher level of corn flour. However, contrary to expectations, crushing force and crispness work both decreased with incorporation of protein sources.

Sadik (2014) investigated the effect of level of chickpea and moisture content of feed on the physical properties of teff flour extruded products. There was more effect of chickpea level on physical properties of products than feed moisture content. Increased level of chickpea resulted in increase in WSI as well as bulk density and decrease in sensory crispiness and diametric expansion ratio. On the other hand, higher WSI resulted due to lower feed moisture. Sensory analyses for crispness revealed that the most accepted product was produced from 10% chickpea blend at 14% feed moisture and had a mean score of 3.93 out of 5. The mean values of bulk density, diametric expansion ratio, WSI and WAI of this product were 127.5 kg m-3, 1.58, 30.92% and 5.7g g-1, respectively. As a result, twin screw extrusion of teff flour blended with 10% chickpea flour would produce an acceptable snack high in protein.

Leguminous and cereals crops provide the major sources of calories and proteins for the large population of the world (Filli et al., 2011). It is considered the number four after ground-nut, cowpea and bambara ground-nut. Grain legumes are recommended because of their protein content which make them indispensable along with cereals in human diet. The plant has been listed among the under-utilized legumes with broad potentials and its seed flour was exploited for biscuit production (Eneche 1999, Badifu 1992).

7. Expertise available with the investigating group/Institute

The PI & Co-PI of project is having enough experience of working in the field of Processing and Food Engineering. Both are the experts in the field of Processing and Food Engineering. The PI is quite capable and qualified to handle this project. The facility and man power is available in the institute for to conduct the process activities in the laboratory.

8. Brief note on Proprietary/Patent Perspective (for projects related to technology development)/Ethics/Animal Welfare/Bio Safety Issues

- No issues are there on these aspects.

9. (a) Expected output

- The proposed process technology will suggest the proper industrial waste utilization of pigeon pea processing for the preparation of RTE product.
- The snack production industries will have better choice to develop new product.
- Protein content in the millet based extruded product will be improved due to supplementation of pigeon pea flour.

(b) Clientele/Stake holders (including economic and socio aspects)

- Snack manufacturers
- Consumers

10. Signatures

[Project Leader] [Co-PIs] ……

11. Comments and signature

[Head of Division]

ANNEXURE- II

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

RESEARCH PROJECT PROFORMA FOR INITIATION OF A RESEARCH PROJECT (RPP - I)

(Refer for Guidelines ANNEXURE-XI (B))

1. Institute Project Code (to be provided by PME Cell)
2. Project Title : Valorization of pulse processing industrial waste for RTE product.
3. Key Words : Pigeon pea powder, pearl millet flour, extrusion, high protein, extruded product
4. (a) Name of the Lead Institute : College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh

   (b) Name of Division/ Regional Center/ Section : AICRP on PHET, Junagadh centre

5. (a) Name of the Collaborating Institute(s) : --

   (b) Name of Division/ Regional Center/ Section of Collaborating Institute(s) : ---
6. Project Team(Name(s) and designation of PI, CC-PI and all project Co-PIs, with time proposed to be spent)

Sr. No.	Name, designation and institute	Status in the project (PI/CC-PI/ Co-PI)	Time to be spent (%)	Work components to be assigned to individual scientist
1.	Dr. M. N. Dabhi, Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	PI	75%	1. Review collection/literature survey 2. Designing of the experiment 3. Procurement of raw materials 4. Quality analysis of the raw materials 5. Experimental trials for the optimization of flour proportion of different ingredient food materials 6. Sensory analysis of extruded products prepared during preliminary trials for the optimization of flour proportion 7. Optimization of the flour proportion based on the data of sensory parameters obtained for the different extruded product. 8. Laboratory trials for the preparation of peanut and millet based extruded product at the optimized flour proportion as per the experimental treatments

				9. Physico-chemical and sensory analysis of the developed extruded products 10. Data collection and its analysis 11. Optimization of the processing parameters based on the experimental data 12. Report writing
2.	Dr. P. R. Davara, Assistant Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	Co-PI	25%	To assist the PI in carrying out the different activities of the project as and when needed

7. Priority Area to which the project belongs : Post Harvest Technology
(If not already in the priority area, give justification)

8. **Project Duration:** Date of Start: 01-03-2024
Likely Date of Completion : 31-03-2026

9. **(a) Objectives**

1. To study the proximate composition of pigeon pea flour, pearl millet flour and different blended proportions of both flour
2. To standardize the blended flour proportion of extruded product from different flour proportions
3. To prepare the extruded product using standardized flour proportion at different machine parameters
4. To study the physical, functional, biochemical and sensory properties of developed extruded product
5. To optimize the machine parameters for production of extruded product using standardized blended flour

(b) Practical utility

1. The pigeon pea powder and pearl millet based RTE product will be made available to the food industries.
2. Protein content in the millet based extruded product will be improved due to supplementation of pigeon pea powder.
3. The new process will develop the millet based extruded product with more nutritional value in comparison to commercially available extruded products.
4. The proposed process technology will suggest the proper utilization pigeon pea processing industrial waste for the preparation of RTE product

10. **Activities and outputs details**

Objective wise	Activity	Month & Year of		Output monitorable target(s)	% to be carried out in different years			Scientist(s) responsible
		Start	Completion		1	2	..	
1.	Review collection/literature survey	March -24	May-24	1. To collect the data on utilization of pigeon pea powder and pearl millet flour in the production of extruded products. 2. To study the work done in the past	100%	--	--	Dr. M. N. Dabhi
2.	Designing of the experiment	June-24	June-24	Designing of the experiments as per the Response surface methodology for the following two aspects 1. Optimization of flour proportion of different food materials 2. Optimization of processing parameters	100%	--	-	Dr. M. N. Dabhi
3.	Procurement of raw materials	July-24	July-24	Raw materials like pigeon pea powder will be collected from the industry and pearl millet defatted peanut flour will be procured	100%	--	--	Dr. M. N. Dabhi

4.	Quality analysis of the raw materials	Aug-24	Oct-24	Physico-chemical characteristics of raw materials will be determined	100%	--	-	Dr. M. N. Dabhi
5.	Experimental trials for the optimization of flour proportion of different ingredient food materials	Nov-24	Dec-24	Preliminary trials will be carried out for the preparation of extruded product using flour of different raw materials selected for the project	100%	100 %	-	Dr. M. N. Dabhi
6.	Sensory analysis of extruded products prepared during preliminary trials for the optimization of flour proportion	Jan-25	Jan-25	The extruded product obtained after preliminary trials will be analysed for their sensory charactristics	--	100 %	--	Dr. M. N. Dabhi
7	Optimization of the flour proportion based on the data of sensory parameters obtained for the different extruded products	Feb-25	July-25	The data of sensory parameters will be analysed through Design Expert software to get the optimized flour proportion.		100 %		Dr. M. N. Dabhi
8	Laboratory trials for the preparation of peanut based extruded product at the optimized flour proportion as per the experimental treatments	Aug-25	Sept-25	Experimental trials will be carried out by taking the flour proportion at the optimized levels by varying the different processing parameters		100 %		Dr. M. N. Dabhi

9.	Physico-chemical and sensory analysis of the developed extruded products	Sept-25	Oct-25	Developed extruded products will be analysed for their physico-chemical and sensory quality	--	100 %	--	Dr. M. N. Dabhi
10.	Data collection and its analysis	Nov-25	Dec-25	The data of various physico-chemical and sensory parameters will be collected and statistically analysed	--	100 %	--	Dr. M. N. Dabhi Dr. P. R. Davara,
11.	Optimization of the processing parameters based on the experimental data	Dec-25	Jan-26	The data of physico-chemical and sensory parameters will be analysed through Design Expert software to get the optimized processing condition.		100 %		Dr. M. N. Dabhi Dr. P. R. Davara,
12.	Report writing	Feb-26	March-26	Compilation of collected data and preparation of report			100 %	Dr. M. N. Dabhi Dr. P. R. Davara,

11. Technical Programme (brief)

Justification :

India is one of the major pulses growing country of the world, accounting roughly for one third of total area under pulses cultivation and one fourth of total world production. Pulses occupy a key position in Indian diet and meet about 30% of the daily protein requirement. Among different countries producing pulses, India ranks first by contributing about 25.77 % to the global pulse production (FAO, 2011). Pulses are a valuable source of proteins, minerals and vitamins in the daily diets of the people. Pigeon pea (Cajanus cajan L.) is one of the important pulse crops of India contributing 20.87 % to the total production of all pulses. India accounts for 90 % of the total world production of pigeon pea (Goyal et al., 2008). In large scale processing of pigeon pea, the per cent loss of cotyledon in terms of powder and broken grain is as high as 12.8 %

and 4.4 %, respectively (Singh, 1995). In view of this, when considering 10 % on an average milling loss of pigeon pea, it amounts to 2.7 lakh tonnes for all India with a value of ₹ 675 crores on dhal basis (Patel *et al.,* 2001). Utilization of the milling loss is an important.

Revolution in living standard and eating habits has opened vast market for snacks food. Extrusion is one such method, through which low-cost nutritious food products could be produced. Extrusion cooking is a high-temperature short-time (HTST) processing technology which offers several advantages over other types of cooking process. The retention of nutrients during extrusion process is better than other cooking processes due to the lower processing time.

<u>Status (review)</u> :

Pearl millet is termed as a Nutri-cereal because of its excellent nutritional profile compared to other cereals. The energy of this millet (361 kcal/100 g) is greater than sorghum and nearly equal to that of brown rice because the lipid content is generally higher (Nambiar et al., 2011).

The pigeon pea grain is considered as most difficult for de-hulling as compared to other pulses owing to its seed coat which is more firmly attached with the cotyledons through a layer of gum and mucilage (Rout et al., 2007). Due to the presence of gummy layer and hard seed coat, it is difficult to de-hull. The primary objective of de-hulling is to remove seed coat from the cotyledons, during which four different fractions, i.e., dhal, broken, powder and husk are obtained. In the process of de-hulling, noticeable amount of cotyledon material and germ are removed resulting into considerable loss. In large scale processing of pigeon pea, the per cent loss of cotyledon in terms of powder and broken grain is as high as 12.8 % and 4.4 %, respectively (Singh, 1995).

Naghera and Dabhi (2023) developed the extruded RTE product using pearl millet and chick pea. The optimized extrusion variables were a die temperature of 138 °C, a screw speed of 320 rpm, and a feed moisture content of 14.5% (w.b.). These results were bulk density as 43.92 kg/m3, true density as 298.53 kg/m3, expansion ratio as 4.07, water solubility index as 22.96 %, water absorption index as 5.31 g/g, water holding capacity as 514.83 %, hardness as 27.33 N, moisture content as 5.12 %, true protein as 5.59 %, calcium as 289.24 ppm, and sensory score as 8.19.

Chakraborty et al. (2009) studied the extrusion cooking of five blends of millets and legume pieces (viz. 12, 16, 20, 24, 28% legume pieces) at varying moisture contents (12, 15, 18, 21, 24% w.b.). The optimum processing conditions were obtained moisture content 24%, w.b., blend ratio 18.7% legume pieces, die head temperature 171.20 °C, barrel temperature 140 °C and screw speed 103.8 rpm. The corresponding textural properties of the extrudates in terms of crispness, hardness and cutting strength were 50, 48.2 and 79.7 N, respectively.

Devi et al. (2013) investigated the effect of incorporation of protein sources such as whey protein isolate, defatted soy flour and mixed legume flour, to the sorghum/corn flour blends at 30%. A 50:50 blend of defatted soy flour and whey protein isolate was also added at 30% to the sorghum/corn flour blends. The resultant formulations were undergone through extrusion and were evaluated for the effects of sorghum/corn flour ratio and protein addition on product expansion, microstructure, mechanical properties and sensory attributes. Higher corn flour level increased the product expansion, which decreased due to incorporation of protein sources. Soy flour added extrudates show a lower expansion ratio (5.3 - 5.4), as compared to that of whey protein isolate (7.7 - 7.9), legume flour (7.1 - 9.9), or whey protein isolate defatted soy flour (6.1 - 6.9). Average crushing force (ranging from 40.9 to 154.87 N) was lower for extrudates with a higher level of corn flour. However, contrary to expectations, crushing force and crispness work both decreased with incorporation of protein sources.

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Leguminous and cereals crops provide the major sources of calories and proteins for the large population of the world (Filli et al., 2011). It is considered the number four after ground-nut, cowpea and bambara ground-nut. Grain legumes are recommended because of their protein content which make them indispensable along with cereals in human diet. The plant has been listed among the under-utilized legumes with broad potentials and its seed flour was exploited for biscuit production (Eneche 1999, Badifu 1992).

Objectives

1. To study the proximate composition of pigeon pea flour, pearl millet flour and different blended proportions of both flour
2. To standardize the blended flour proportion of extruded product from different flour proportions
3. To prepare the extruded product using standardized flour proportion at different machine parameters
4. To study the physical, functional, biochemical and sensory properties of developed extruded product
5. To optimize the machine parameters for production of extruded product using standardized blended flour

Technical programme

❖ **Extruded product preparation**

The procedure to be followed for the preparation of extruded product using twin screw extruder is presented in the process flow chart as given in Fig. 1.

❖ **Experimental for standardization of flour proportion**

To prepare the extruded product using pigeon pea flour and pearl millet flour at different proportions and to standardize the blended proportions for production of RTE product, flours will be fixed based on the sensory evaluation. Among six proportions as given in table, the proportion which will get the maximum sensory score will be fused for further optimizing extrusion variables. For flour proportion selection extrusion variables will be Die temperature 120 ^{o}C, Screw speed 275 rpm and Moisture content 16% w.b.

Table 6.1 : Proportion of pearl millet flour and pigeon pea flour to be used

Feed composition	Pearl millet (%)	Pigeon pea (%)	Total quantity
K1	100	0	100
K2	90	10	100
K3	80	20	100
K4	70	30	100
K5	60	40	100
K6	50	50	100

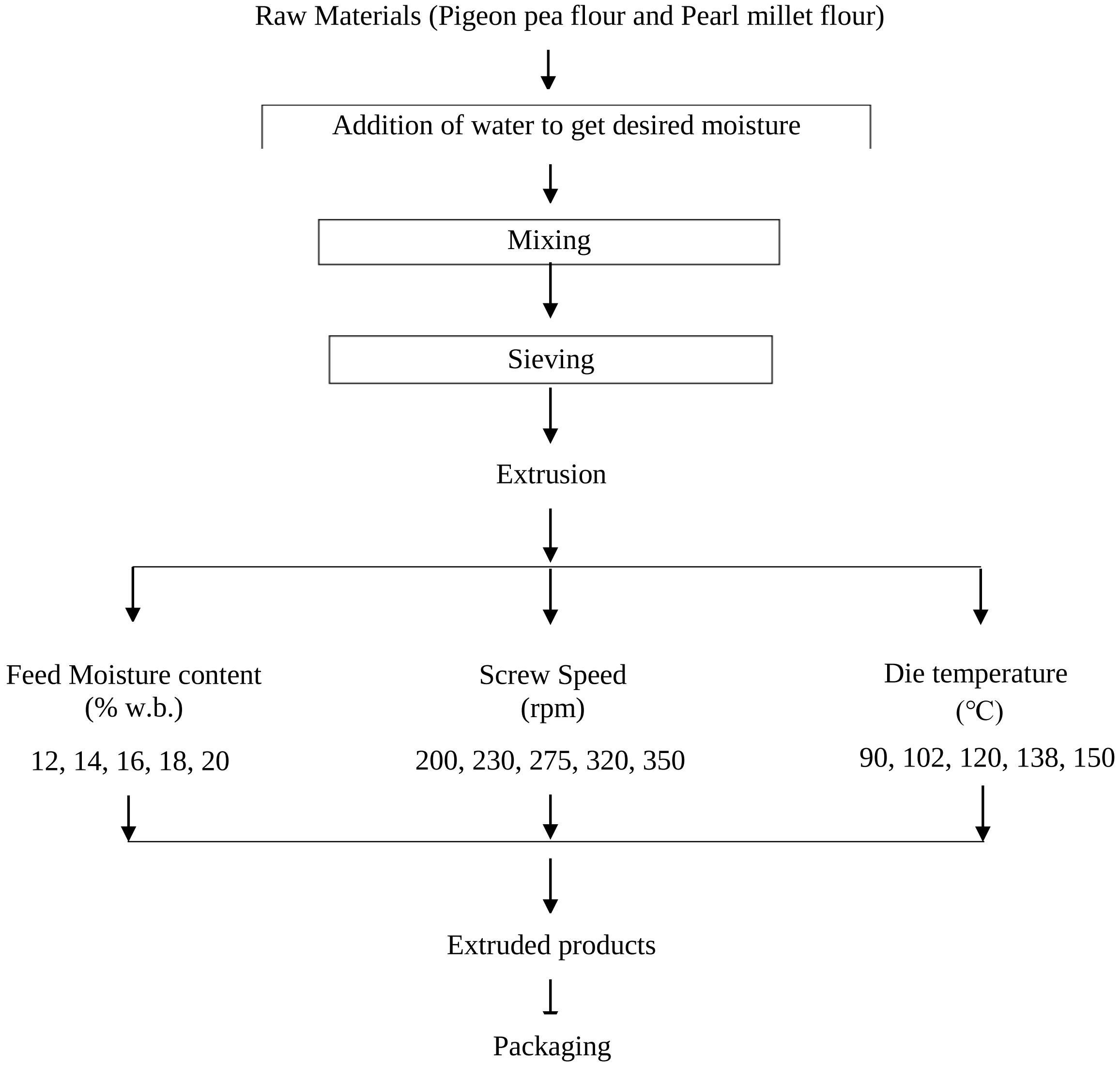

Fig. 6.1 : Process flow chart for preparation of extruded product.

Experimental design

Response Surface Methodology will be used for designing the experiment trials. A Central Composite Rotatable Design (CCRD) of 3 variables at 5 levels each with 6 centre point combinations (Khuri and Cornell, 1987).

Treatment details:

1. Feed moisture content (%) (X1): Five levels (12, 14, 16, 18, 20)
2. Screw speed (rpm) (X2) : Five levels (200, 230, 275, 320, 350)
3. Die temperature (°C) (X3): Five levels (90, 102, 120, 138, 150)

- **Independent parameters :**

Table 6.2 : Coded and uncoded values of independent parameters to be used in the optimization of processing condition for the preparation of extruded product

Parameters	Code	Coded and Uncoded value				
		-1.68	**-1**	**0**	**+1**	**+1.68**
Moisture content (%)	(X_1)	12	14	16	18	20
Screw speed (rpm)	(X_2)	200	230	275	320	350
Die head temperature (°C)	(X_3)	90	102	120	138	150

Dependent parameteres:

- **Extrusion variables**
  - Torque (Nm)
  - Mass flow rate (g/min)
- **Physical and functional Parameters of extruded product**
  - Bulk density (g/ml)
  - True density (g/ml)
  - Expansion ratio (%)
  - Water solubility index (%)
  - Water absorption index (%)
  - Hardness (%)
  - Crispness (%)
- **Biochemical parameters of extruded product**
  - Moisture content (%)
  - Calcium
  - Total Carbohydrate (%)
  - Iron
  - True Protein (%)
  - Zinc
  - Crude fibre
  - Calorific value
  - Total ash (%)
- **Sensory parameters**
  - Chewiness
  - Colour
  - Hardness
  - Overall acceptability
  - Taste

❖ **Statistical Analysis**

The statistical analysis of the experimental data will be carried out using RSM to observe the significance of the effect of various process parameters on the various response by Khuri and Cornell (1987).

Possible outputs :

- The proposed process technology will suggest the proper industrial waste utilization of pigeon pea processing for the preparation of RTE product.
- The snack production industries will have better choice to develop new product.
- Protein content in the millet based extruded product will be improved due to supplementation of pigeon pea flour.

References :

- Chakraborty, S. K., Singh, D. S., Kumbhar, B. K. and Singh, D. (2009). Process parameter optimization for textural properties of ready-to-eat extruded snack food from millet and legume pieces blends. Journal of Texture Studies, 40(6): 710-726.
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- Rout, B., Sahoo, S., Senapati, P. K. (2007) Effect of pre milling treatment on protein and carbohydrate content in tribal pulses. Indian J Traditional Knowledge. 6: 69-71.
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- Singh U. Method of dehulling of pulses: A critical appraisal. Journal of Food Science and Technology. 1995;32(2):81–93.

12. **Financial Implications (in Lakhs) : Rs. 32.32 lakhs**

(A) Financed by the institute

12.1 Manpower (Salaries / Wages)

Sr. No.	Staff Category	Man months	Cost
1.	Scientific	23	30,00,000
2.	Technical	5	2,00,000
3.	Supporting	--	--
4.	SRFs/RAs	--	--
5.	Contractual	--	--
	Total	28	32,00,000

12.2 Research/Recurring Contingency

Sr. No.	Item	Year (1)	Year (2)	Year (3)	Total
1.	Consumables	10000	10000	--	20000
2.	Travel	5000	--	--	5000
3.	Field Preparation/ Planting/ Harvesting (Man-days/costs)	--	--	--	--
4.	Inter-cultivation & Dressing (Man-days/costs)	--	--	--	--
5.	Animal/Green house/Computer Systems/Machinery Maintenance	2000	--	--	2000
6.	Miscellaneous(Other costs)	5000	--	--	5000
	Total(Recurring)	22000	10000	--	32000

Justification : ---

12.3 Non-recurring (Equipment)

Sr. No.	Item	Year (1)	Year (2)	Year (3)	Total
1.		--	--	--	--
2.		--	--	--	--
	Total (Non-recurring)	--	--	--	--

Justification : ---

12.4 Any Other Special Facility required (including cost)

12.5 Grand Total (12.1 to 12.4)

Item	Year (1)	Year (2)	Year (3)	Total
Grand Total	16,22,000	16,10,000	--	32,32,000

(B) Financed by an organization other than the Institute (if applicable) : No

- Name of Financing Organization : NA
- Total Budget of the Project :
- Budget details

S. No.	Item	Year(1)	Year(2)	Year (3)…	Total
1	Recurring Contingency				
	Travelling Allowance	--	--	--	--
	Workshops	--	--	--	--
	Contractual Services/ Salaries	--	--	--	--
	Operational Cost	--	--	--	--
	Consumables	--	--	--	--
2	Non - Recurring Contingency				
	Equipment	--	--	--	--
	Furniture	--	--	--	--
	Vehicle	--	--	--	--
	Others (Miscellaneous)	--	--	--	--
3	HRD Component				
	Training	--	--	--	--
	Consultancy	--	--	--	--
4	Works (i) New & (ii) Renovation	--	--	--	--
5	Institutional Charges				

13. Expected Output: Process will be standardised for utilization of pigeon pea dal industrial waste for preparation of pigeon pea powder and pearl millet flour based RTE product.

14. Expected Benefits and Economic Impact
    - The proposed process technology will suggest the proper industrial waste utilization of pigeon pea processing for the preparation of RTE product.
    - The snack production industries will have better choice to develop new product.
    - Protein content in the millet based extruded product will be improved due to supplementation of pigeon pea flour.

15. Risk Analysis
16. Signature

Project Leader Co-PI-I Co-PI-II

17. Signature of HoD
18. Signature of JD (R)/ Director

ANNEXURE - III

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

CHECKLIST FOR SUBMISSION OF RPP-I

(Refer for Guidelines ANNEXURE-XI(C))

1. Project Title: Valorization of pulse processing industrial waste for RTE product.
2. Date of Start & Duration: Date of Start: 01-03-2024

   Likely Date of Completion: 31-03-2026
3. Institute Project [√] or Externally Funded [ ]
4. Estimated Cost of the Project : 32.32 lakh
5. Project Presented in the Divisional/Institutional Seminar? ~~Yes~~ / No
6. Have suggested modifications incorporated? ~~Yes~~ / No
7. Status Report enclosed Yes / ~~No~~
8. Details of work load of investigators in approved ongoing projects:

Project Leader				Co-PI – I				Co-PI – II…
Proj. Code.	% Time spent	Date of start	Date of compl-etion	Proj. Code.	% Time spent	Date of start	Date of completion	………

9. Work Plan/Activity Chart enclosed Yes / ~~No~~
10. Included in Institute Plan Activity Yes / ~~No~~
11. Any previous Institute/Adhoc/Foreign aided projects on similar lines? Yes / ~~No~~
12. New equipment required for the project ~~Yes~~ / No
13. Funds available for new equipment ~~Yes~~ / No
14. Signatures

Project Leader   Co-PI-I   Co-PI-II   Co-PI–n

HOD/PD/I/c

ANNEXURE - IV

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

APPRAISAL BY THE PME CELL OF RPP-I

(Refer for Guidelines ANNEXURE-XI (D))

1. Institute Name: Junagadh Agricultural University
2. Project Title Valorization of pulse processing industrial waste for RTE product.
3. On scale 1-10 give score to (a) to (j)

(a)	Relevance of research questions	☐
(b)	Addressing priority of the institute and/or National priority	☐
(c)	New innovativeness expected in the study	☐
(d)	Appropriateness of design/techniques for the questions to be answered	☐
(e)	Elements of bias addressed in the study	☐
(f)	Adequacy of scientist(s) time allocation	☐
(g)	Extent of system review and meta analysis	☐
(h)	Effective control to experiments	☐
(i)	Economic evaluation and cost efficiency analysis	☐
(j)	How appropriately the expected output answers the questions being addressed in the specific subject matter/area (Basic/Applied/Translational/Others)?	☐
	***Total Score out of 100**	

* The score obtained is suggestive of the overall quality ranking of the project

4. Was there any other project carried in the past in the same area/topic?

Yes ☐ No ☐

If yes, list the project numbers.

5. Signature of PME Cell Incharge

NEW INVESTIGATION – III

ANNEXURE - I

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

PROFORMA FOR PREPARATION OF STATUS REPORT

FOR PROPOSAL OF A NEW RESEARCH PROJECT

(Refer for Guidelines ANNEXURE-XI(A))

1. **Institute Name :** College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh
2. **Title of the project :** Development of protein enriched Ready-to-Eat extruded product ideal for fasting by supplementing defatted peanut flour.
3. **Type of research project :** Basic/~~Applied/Extension/Farmer Participatory/Other~~ (specify)
4. **Genesis and rationale of the project :**

Fasting is a ritual from many thousands of years which is a healing and a religious or spiritual process. Fasting is an integral part of the Indian culture and tradition and thought to be important as it nourishes both the physical and spiritual needs of the person. Also many religions including Christianity, Judaism and the Eastern religions have encouraged fasting for penitence, mourning, sacrifice and union with the God. During fasting people would like to eat traditional product prepared from sago, sweet potato, potato and fruits. Indian people are preferred khichadi, sabudana (sago) vada, sweet potato kheer, potato vada and fruit juices made traditionally at home. But there are fewer choices available for commercial product in market such as potato chips and banana chips snacks. In recent years, the demand for snacks with improved nutritional and functional properties has been increased. Among these, expanded product has gained preference of both consumers and producers (Rathod and Annapure, 2016).

Peanut, amaranth, barnyard millet and tapioca pearl are the few food materials which are used in the preparation of dishes during fasting. Peanut is a rich and promising source of protein and somewhere similar to that of soybean. On account of growing demand from food industries and health-conscious consumers, study and developments in peanut based products, technologies and machineries are necessary of peanut growing and processing regions. Amaranth has one of the highest levels of protein that is also easier for the human body to absorb. It also contains an amino acid called Lysine which is missing from other cereals, making it a complete protein source. Phytosterols present in Amaranth help lower cholesterol. One of the main reason of its popularity in India as it has become an important part in Hindu fasting rituals. Barnyard millet is an appropriate food for patients intolerant to gluten which causes celiac disease. Seeds of this crop are nutritious. Tapioca pearls or sabudana primarily contain starch, a simple carbohydrate that is easily digested and is also a direct source of energy. It is low in sodium content, practically has no cholesterol and comprises significant quantities of calcium, for strengthening bones. It is used in the preparation of various traditional dishes, snacks such as wafers, fried chips and also used as animal feed at household level.

5. **Knowledge/Technology gaps and justification for taking up the present project including the questions to be answered :**

The snack industry is the fastest growing food sector and is the king in producing convenience foods. Extrusion plays a major role in producing such kind of popular foods like puffs, pasta, cereals, gums etc. Extruded snacks are processed food products made from a combination of ingredients that are either pushed through a mold or precision cut. Consumer acceptance of extruded foods is mainly due to the convenience, value, attractive appearance, and texture found to be particular for these foods, especially when it concerns to snack products. Novel ingredients, cutting-edge extrusion technology, and innovative processing methods are combined to yield new snack products with ever widening appeal to health-conscious consumers that are seeking different textures and mouth feeling with convenience.

During the various festivals celebrated in India, fasting is an integral part of Hindu rituals. Amaranth, barnyard millet, tapioca pearls and peanuts are very popular food materials which are utilized in the preparation of various fast foods on the occasion of various Hindu festivals. Extruded snacks with multiple cereals and tubers are very famous food products consumed by peoples of all ages. No any extruded products are available in the market which can be used for the fasting purpose. Peanut, amaranth, barnyard and tapioca pearls are easily available and economical raw material source for production of extruded product. Defatted peanut flour is very rich in the protein content and can play a good role in improving the protein level in the extruded products. Amaranth, barnyard and tapioca pearls also contains a very important nutritional components required by our body. Further, all these food materials are found suitable for preparation of fasting food as per the Hindu rituals. A very negligible information is available on the utilization of all these food materials in the preparation of extruded products. In view of this, the present investigation is undertaken to develop extruded snacks suitable for fasting by utilizing peanut, amaranth, barnyard and tapioca pearl flours as a raw material.

6. **Critical review of present status of the technology at national and international levels along with complete references :**

Pathak and Kochhar (2017) reported that a majority of world population suffers from qualitative and quantitative insufficiency of dietary protein and calories intake. In all such cases, physiological maintenance and growth are impaired and malnutrition results. In this context extrusion is a beneficial process. Extrusion is one of the commonly adopted processing technique by food industries which employs mixing, forming, texturing and cooking to develop a novel food product. It is one of the contemporary food processing technologies applied for development of variety of snacks, specialty and supplementary foods. The versatility of extrusion technology makes it convenient for development of nutritionally rich extruded products with wide range of raw material and useful as a source of vehicle for value addition. Extruded products have less moisture, longer shelf life, microbiologically safe and there are plenty of ways to make value added and fortified extruded products with combination of different raw materials. This review comprehensively covers the potential of extrusion technology in development of various types of value added extruded products that can be popularized for combating malnutrition globally.

Davara *et al.* (2022) developed the extruded snack products by blending of corn flour and defatted peanut flour using twin screw extruder. The combined effects of feed moisture content, defatted peanut flour content, die head temperature and screw speed on the important physical (expansion ratio) and functional (water absorption index, water holding capacity and water solubility index) properties of extrudates were studied. The Response Surface Methodology (RSM) was used in designing the experiment. Since, the defatted peanut flour is poor in starch content, the flour content restricted the gelatinization and limited the expansion of the product. Defatted peanut flour was found to be suitable for the preparation of extruded snacks with the appropriate blending corn flour as a base material. The optimum treatment condition was found as 13% feed moisture content, 26% defatted peanut flour, 135 °C die head temperature and 250 rpm screw speed for the production of extruded product by blending of defatted peanut flour with corn flour.

Dokić *et al*. (2009) studied that extruded amaranth grain products have specific aroma and can be used as snack food, supplement in breakfast cereals, or as raw material for further processing. Extruded products of corn-amaranth grits blends, containing 20% or 50% amaranth grain grits, were produced by extrusion-cooking using a laboratory Brabender single screw extruder 20 DN. Extrudates with various texture were obtained. During extrusion process starch granules are partially degraded, hence rheological properties were examined. All samples exhibited thixotropic flow behavior. Those samples in which part of the corn grits was replaced with amaranth one had lower viscosity and exhibited lower level of structuration during storage. Increasing amount of amaranth grits in the extrusion blend causes increase of density and hardness of the extrudated products and decrease in expansion index. When part of the corn grits is replaced with amaranth grits viscosity of gels decreases compared to pure corn grits.

Rajashekar *et al.* (2019) developed the extruded product using barnyard millet (20-30%), finger millet (10-30%), corn grits (40-60%), and green gram dhal (10%) blends. The extruded products were compared with control Corn grits (100%). Physical and sensory qualities of extruded products were investigated. Bulk density was reduced with increasing corn grits content and expansion ratio increased with increasing corn grits composition. The proximate analysis was carried out for all samples. Compare to all samples with control the T1 sample (barnyard millet, finger millet, corn grits, green gram dhal were 30,20,40,10 percent respectively) showed good attributes and which was combination of cereal and pulse so it may be balance our protein requirement. The selected extruded product T1 studied shelf life studied at room temperature till 45 days the product was good.

Patel *et al.* (2016) developed a protein-rich puffed snack using a twin screw extruder and the effects of varying levels of tapioca starch (11 to 40 parts), rennet casein (6 to 20 parts) and sorghum flour (25 to 75 parts) on physico-chemical properties and sensory attributes of the product studied. An increasing level of sorghum flour resulted in a decreasing whiteness (Hunter L* value) of the snack. Although the starch also generally tended to make the product increasingly darker, both starch and casein showed redness parameter (a* value) was not significantly influenced by the ingredients levels, the yellow hue (b* value) generally declined with the increasing sorghum level. Tapioca starch significantly increased the expansion ratio and decreased the bulk density and hardness value of the snack, whereas the opposite effects seen in case of sorghum flour. While the water solubility index (WSI) was enhanced by starch, water absorption index was appreciably improved by sorghum. Incorporation of casein (up to 25 %) improved the sensory colour and texture scores, and so also the overall acceptability rating of the product. Sorghum flour had an adverse impact on all the sensory attributes whereas starch only on the colour score. The casein or starch level had no perceivable effect on the product's flavour score. The response surface data enabled optimization of the snack-base formulation for the desired protein level or desired sensory characteristics

7. Expertise available with the investigating group / Institute

The PI & Co-PI of project is having enough experience of working in the field of Processing and Food Engineering. Both the project members are the experts in the field of Processing and Food Engineering. The PI is quite capable and qualified to handle this project. The facility and man power is available in the institute to conduct the experimental activities in the laboratory.

8. Brief note on Proprietary/Patent Perspective (for projects related to technology development)/Ethics/Animal Welfare/Bio Safety Issues

- No issues are there on these aspects.

9. (a) Expected output

i. No any fasting snack product is available in the market. The new peanut based extruded product along with other food materials which is suitable for fasting will be developed.

ii. Protein content in the extruded product will be improved due to blending of peanut flour. Other food materials like amaranth, barnyard millet and tapioca pearl are also very nutritious and suitable for preparation of extruded product. The new process will develop the fasting snack product with more nutritional value in comparison to commercially available extruded products.

iii. The flour proportion of different food materials will be optimized to prepare the fasting snack product with good sensory characteristics.

iv. The process parameters for the preparation of peanut flour based fasting extruded product will be optimized.

v. The proposed process technology will suggest the proper byproduct utilization of peanut for the preparation of value added product.

(b) Clientele/Stake holders (including economic and socio aspects)

- Peanut growers
- Peanut processors
- Sauce manufacturers
- Consumers

10. Signatures

[Project Leader] [Co-PIs] ……

11. Comments and signature

[Head of Division]

ANNEXURE- II

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

RESEARCH PROJECT PROFORMA FOR INITIATION OF A RESEARCH PROJECT (RPP - I)
(Refer for Guidelines ANNEXURE-XI (B))

1. Institute Project Code (to be provided by PME Cell)

2. Project Title : Development of protein enriched Ready-to-Eat extruded product ideal for fasting by supplementing defatted peanut flour.

3. Key Words : Defatted peanut flour, amaranth, barnyard millet, tapioca pearl, extrusion cooking, fasting

4. (a) Name of the Lead Institute : College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh
(b) Name of Division/ Regional Center/ Section : AICRP on PHET, Junagadh centre

5. (a) Name of the Collaborating Institute(s) : --
(b) Name of Division/ Regional Center/ Section of Collaborating Institute(s) : ---

6. Project Team(Name(s) and designation of PI, CC-PI and all project Co-PIs, with time proposed to be spent)

Sr. No.	Name, designation and institute	Status in the project (PI/CC-PI/ Co-PI)	Time to be spent (%)	Work components to be assigned to individual scientist
1.	Dr. P. R. Davara, Assistant Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	PI	75%	1. Review collection/literature survey 2. Designing of the experiment 3. Procurement of raw materials 4. Quality analysis of the raw materials 5. Experimental trials for the optimization of flour proportion of different ingredient food materials 6. Sensory analysis of extruded products prepared during preliminary trials for the optimization of flour proportion 7. Optimization of the flour proportion based on the data of sensory parameters obtained for the different extruded product 8. Laboratory trials for the preparation of peanut based extruded product at the optimized flour proportion as per the experimental treatments

				9. Physico-chemical and sensory analysis of the developed extruded products 10. Data collection and its analysis 11. Optimization of the processing parameters based on the experimental data 12. Report writing
2.	Dr. M. N. Dabhi, Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	Co-PI	15%	To assist the PI in carrying out the different activities of the project as and when needed
3.	Prof. A. M. Joshi Asst. Microbiologist AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	Co-PI	10%	To assist the PI in biochemical analysis of the raw material and developed product

7. Priority Area to which the project belongs : Post Harvest Technology

(If not already in the priority area, give justification)

8. Project Duration: Date of Start: 01-03-2024 Likely Date of Completion **:** 31-03-2025

9. (a) Objectives

1. To develop extruded product from defatted peanut flour, amaranth flour, barnyard millet flour and tapioca flour at different blending ratio.
2. To optimize the blending ratio of defatted peanut flour, amaranth flour, barnyard millet flour and tapioca flour for the preparation of extruded products based on sensory parameters.
3. To develop extruded product from peanut flour and other fasting food materials under different processing conditions.
4. To evaluate the physico-chemical, functional and sensory properties of developed extruded products.
5. To optimize the processing condition for the development of protein enriched extruded product suitable for fasting.

(b) Practical utility

1. No any fasting snack product is available in the market. The new peanut based extruded product along with other food materials which is suitable for fasting will be developed.
2. Protein content in the extruded product will be improved due to blending of peanut flour. Other food materials like amaranth, barnyard millet and tapioca pearl are also very nutritious and suitable for preparation of extruded product. The new process will develop the fasting snack product with more nutritional value in comparison to commercially available extruded products.

3. The flour proportion of different food materials will be optimized to prepare the fasting snack product with good sensory characteristics.
4. The process parameters for the preparation of peanut flour based fasting extruded product will be optimized.
5. The proposed process technology will suggest the proper byproduct utilization of peanut for the preparation of value added product.

10. Activities and outputs details

Objective wise	Activity	Month & Year of		Output monitorable target(s)	% to be carried out in different years			Scientist(s) responsible
		Start	Completion		1	2	..	
1.	Review collection/literature survey	March -24	Marh-24	1. To collect the data on utilization of peanut, amaranth, barnyard millet and tapioca pearl flours in the production of extruded products. 2. To study the work done in the past	100%	--	--	Dr. P. R. Davara
2.	Designing of the experiment	March -24	Marh-24	Designing of the experiments as per the Response surface methodology for the following two aspects 1. Optimization of flour proportion of different food materials 2. Optimization of processing parameters	100%	--	-	Dr. P. R. Davara
3.	Procurement of raw materials	April-24	April-24	Raw materials like defatted peanut flour, amaranth flour, barnyard millet flour and tapioca pearl flour will be procured	100%	--	--	Dr. P. R. Davara

4.	Quality analysis of the raw materials	May-24	May-24	Physico-chemical characteristics of raw materials will be determined	100%	--	-	Dr. P. R. Davara
5.	Experimental trials for the optimization of flour proportion of different ingredient food materials	June-24	June-24	Preliminary trials will be carried out for the preparation of extruded product using flour of different raw materials selected for the project	--	100 %	-	Dr. P. R. Davara
6.	Sensory analysis of extruded products prepared during preliminary trials for the optimization of flour proportion	June-24	June-24	The extruded product obtained after preliminary trials will be analysed for their sensory charactristics	--	100 %	--	Dr. P. R. Davara
7	Optimization of the flour proportion based on the data of sensory parameters obtained for the different extruded products	July-24	July-24	The data of sensory parameters will be analysed through Design Expert software to get the optimized flour proportion.	--	100 %	--	Dr. P. R. Davara
8	Laboratory trials for the preparation of peanut based extruded product at the optimized flour proportion as per the experimental treatments	Aug-24	Aug-24	Experimental trials will be carried out by taking the flour proportion at the optimized levels by varying the different processing parameters	--	100 %	--	Dr. P. R. Davara

9.	Physico-chemical and sensory analysis of the developed extruded products	Aug-24	Aug-24	Developed extruded products will be analysed for their physico-chemical and sensory quality	--	100 %	--	Dr. P. R. Davara Prof. A. M. Joshi
10.	Data collection and its analysis	Sept-24	Sept-24	The data of various physico-chemical and sensory parameters will be collected and statistically analysed	--	100 %	--	Dr. P. R. Davara, Dr. M. N. Dabhi
11.	Optimization of the processing parameters based on the experimental data	Oct-24	Nov-24	The data of physico-chemical and sensory parameters will be analysed through Design Expert software to get the optimized processing condition.	--	100 %	--	Dr. P. R. Davara, Dr. M. N. Dabhi
12.	Report writing	Dec-24	March-25	Compilation of collected data and preparation of report	--	100 %	--	Dr. P. R. Davara, Dr. M. N. Dabhi

11. Technical Programme (brief)

Justification :

Fasting is a ritual from many thousands of years which is a healing and a religious or spiritual process. Fasting is an integral part of the Indian culture and tradition and thought to be important as it nourishes both the physical and spiritual needs of the person. Also many religions including Christianity, Judaism and the Eastern religions have encouraged fasting for penitence, mourning, sacrifice and union with the God. During fasting people would like to eat traditional product prepared from sago, sweet potato, potato and fruits. Indian people are preferred khichadi, sabudana (sago) vada, sweet potato kheer, potato vada and fruit juices made traditionally at home. But there are fewer choices available for commercial product in market such as potato chips and banana chips snacks. In recent years, the demand for snacks with improved nutritional and functional properties has been increased. Among these, expanded product has gained preference of both consumers and producers (Rathod and Annapure, 2016).

Peanut, amaranth, barnyard millet and tapioca pearl are the few food materials which are used in the preparation of dishes during fasting. Peanut is a rich and promising source of protein and somewhere similar to that of soybean. On account of growing demand from food industries and health-conscious consumers, study and developments in peanut based products, technologies and machineries are necessary of peanut growing and processing regions. Amaranth has one of the highest levels of protein that is also easier for the human body to absorb. It also contains an amino acid called Lysine which is missing from other cereals, making it a complete protein source. Phytosterols present in Amaranth help lower cholesterol. One of the main reason of its popularity in India as it has become an important part in Hindu fasting rituals. Barnyard millet is an appropriate food for patients intolerant to gluten which causes celiac disease. Seeds of this crop are nutritious. Tapioca pearls or sabudana primarily contain starch, a simple carbohydrate that is easily digested and is also a direct source of energy. It is low in sodium content, practically has no cholesterol and comprises significant quantities of calcium, for strengthening bones. It is used in the preparation of various traditional dishes, snacks such as wafers, fried chips and also used as animal feed at household level.

The snack industry is the fastest growing food sector and is the king in producing convenience foods. Extrusion plays a major role in producing such kind of popular foods like puffs, pasta, cereals, gums etc. Extruded snacks are processed food products made from a combination of ingredients that are either pushed through a mold or precision cut. Consumer acceptance of extruded foods is mainly due to the convenience, value, attractive appearance, and texture found to be particular for these foods, especially when it concerns to snack products. Novel ingredients, cutting-edge extrusion technology, and innovative processing methods are combined to yield new snack products with ever widening appeal to health-conscious consumers that are seeking different textures and mouth feeling with convenience.

During the various festivals celebrated in India, fasting is an integral part of Hindu rituals. Amaranth, barnyard millet, tapioca pearls and peanuts are very popular food materials which are utilized in the preparation of various fast foods on the occasion of various Hindu festivals. Extruded snacks with multiple cereals and tubers are very famous food products consumed by peoples of all ages. No any extruded products are available in the market which can be used for the fasting purpose. Peanut, amaranth, barnyard and tapioca pearls are easily available and economical raw material source for production of extruded product. Defatted peanut flour is very rich in the protein content and can play a good role in improving the protein level in the extruded products. Amaranth, barnyard and tapioca pearls also contains a very important nutritional components required by our body. Further, all these food materials are found suitable for preparation of fasting food as per the Hindu rituals. A very negligible information is available on the utilization of all these food materials in the preparation of extruded products. In view of this, the present investigation is undertaken to develop extruded snacks suitable for fasting by utilizing peanut, amaranth, barnyard and tapioca pearl flours as a raw material.

Status (review) :

Pathak and Kochhar (2017) reported that a majority of world population suffers from qualitative and quantitative insufficiency of dietary protein and calories intake. In all such cases, physiological maintenance and growth are impaired and malnutrition results. In this context extrusion is a beneficial process. Extrusion is one of the commonly adopted processing technique by food industries which employs mixing, forming, texturing and cooking to develop a novel food product. It is one of the contemporary food processing technologies applied for development of variety of snacks, specialty and supplementary foods. The versatility of extrusion technology makes it convenient for development of nutritionally rich extruded products with wide range of raw material and useful as a source of vehicle for value addition. Extruded products have less moisture, longer shelf life, microbiologically safe and there are plenty of ways to make value added and fortified extruded products with combination of different raw materials. This review comprehensively covers the potential of extrusion technology in development of various types of value added extruded products that can be popularized for combating malnutrition globally.

Davara *et al.* (2022) developed the extruded snack products by blending of corn flour and defatted peanut flour using twin screw extruder. The combined effects of feed moisture content, defatted peanut flour content, die head temperature and screw speed on the important physical (expansion ratio) and functional (water absorption index, water holding capacity and water solubility index) properties of extrudates were studied. The Response Surface Methodology (RSM) was used in designing the experiment. Since, the defatted peanut flour is poor in starch content, the flour content restricted the gelatinization and limited the expansion of the product. Defatted peanut flour was found to be suitable for the preparation of extruded snacks with the appropriate blending corn flour as a base material. The optimum treatment condition was found as 13% feed moisture content, 26% defatted peanut flour, 135 °C die head temperature and 250 rpm screw speed for the production of extruded product by blending of defatted peanut flour with corn flour.

Dokić *et al*. (2009) studied that extruded amaranth grain products have specific aroma and can be used as snack food, supplement in breakfast cereals, or as raw material for further processing. Extruded products of corn-amaranth grits blends, containing 20% or 50% amaranth grain grits, were produced by extrusion-cooking using a laboratory Brabender single screw extruder 20 DN. Extrudates with various texture were obtained. During extrusion process starch granules are partially degraded, hence rheological properties were examined. All samples exhibited thixotropic flow behavior. Those samples in which part of the corn grits was replaced with amaranth one had lower viscosity and exhibited lower level of structuration during storage. Increasing amount of amaranth grits in the extrusion blend causes increase of density and hardness of the extrudated products and decrease in expansion index. When part of the corn grits is replaced with amaranth grits viscosity of gels decreases compared to pure corn grits.

Rajashekar *et al.* (2019) developed the extruded product using barnyard millet (20-30%), finger millet (10-30%), corn grits (40-60%), and green gram dhal (10%) blends. The extruded products were compared with control Corn grits (100%). Physical and sensory qualities of extruded products were investigated. Bulk density was reduced with increasing corn grits content and expansion ratio increased with increasing corn grits composition. The proximate analysis was carried out for all samples. Compare to all samples with control the T1 sample (barnyard millet, finger millet, corn grits, green gram dhal were 30,20,40,10 percent respectively) showed good attributes and which was combination of cereal and pulse so it may be balance our protein requirement. The selected extruded product T1 studied shelf life studied at room temperature till 45 days the product was good.

Patel *et al.* (2016) developed a protein-rich puffed snack using a twin screw extruder and the effects of varying levels of tapioca starch (11 to 40 parts), rennet casein (6 to 20 parts) and sorghum flour (25 to 75 parts) on physico-chemical properties and sensory attributes of the product studied. An increasing level of sorghum flour resulted in a decreasing whiteness (Hunter L* value) of the snack. Although the starch also generally tended to make the product increasingly darker, both starch and casein showed redness parameter (a* value) was not significantly influenced by the ingredients levels, the yellow hue (b* value) generally declined with the increasing sorghum level. Tapioca starch significantly increased the expansion ratio and decreased the bulk density and hardness value of the snack, whereas the opposite effects seen in case of sorghum flour. While the water solubility index (WSI) was enhanced by starch, water absorption index was appreciably improved by sorghum. Incorporation of casein (up to 25 %) improved the sensory colour and texture scores, and so also the overall acceptability rating of the product. Sorghum flour had an adverse impact on all the sensory attributes whereas starch only on the colour score. The casein or starch level had no perceivable effect on the product's flavour score. The response surface data enabled optimization of the snack-base formulation for the desired protein level or desired sensory characteristics.

Objectives

a. To develop extruded product from defatted peanut flour, amaranth flour, barnyard millet flour and tapioca flour at different blending ratio.
b. To optimize the blending ratio of defatted peanut flour, amaranth flour, barnyard millet flour and tapioca flour for the preparation of extruded products based on sensory parameters.
c. To develop extruded product from peanut flour and other fasting food materials under different processing conditions.
d. To evaluate the physico-chemical, functional and sensory properties of developed extruded products.
e. To optimize the processing condition for the development of protein enriched extruded product suitable for fasting.

Technical programme

❖ Extruded product preparation

The procedure to be followed for the preparation of extruded product using twin screw extruder is presented in the process flow chart as given in Fig. 1.

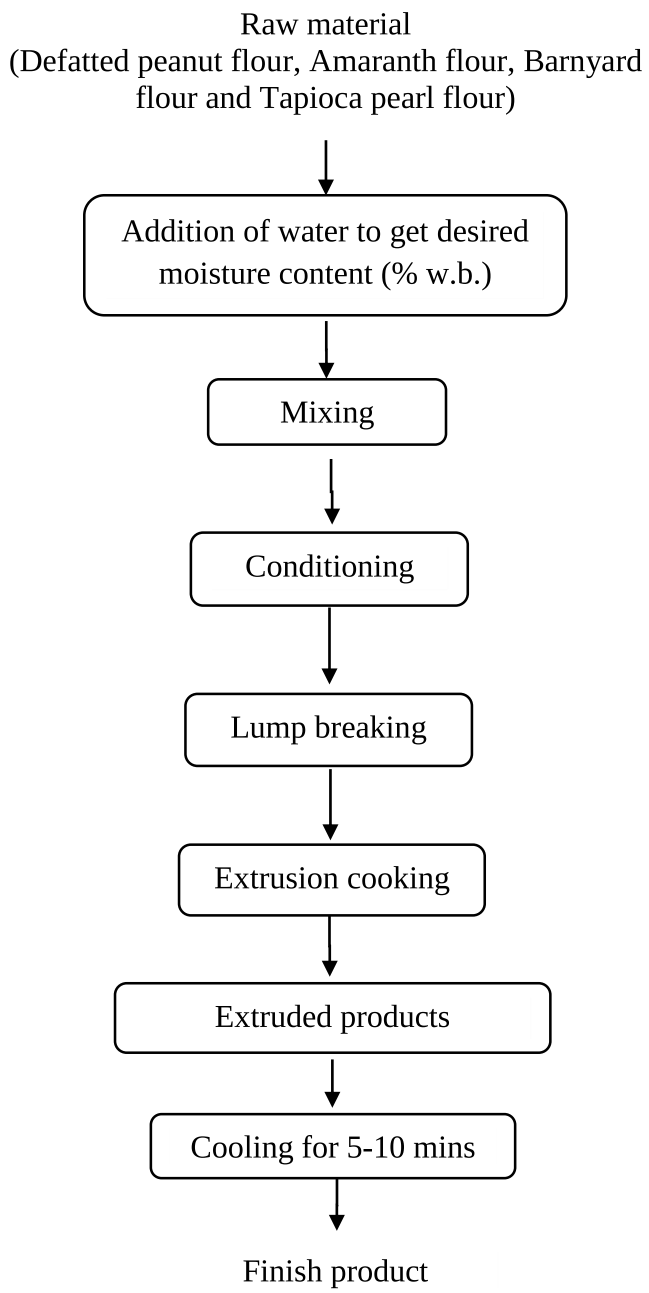

Fig. 7.1 : Process flow chart for preparation of extruded product.

❖ **Optimization of blending ratio of different flours for development of extruded product suitable for fasting**

Experiment trials will be conducted to optimize the blending ratio of different flours, *viz.* defatted peanut flour, amaranth flour, barnyard flour and tapioca flours, in the preparation of extruded products. The different proportions of these flours are to be mixed with each other as suggested by the Mixture Design of Response Surface Methodology (RSM) as given in the Table 1. The extruded products will be prepared by keeping the feeder temperature (60°C), barrel temperature (100°C), die temperature (135°C) and screw rpm (250 rpm) at constant level. The extruded products as prepared by the different flour combinations will be evaluated for their sensory paraments (Appearance, Taste, Colour, Crispness and Overall Acceptability) using 9-point hedonic scale method. Then the optimization of the flour proportion will be carried out using RSM based on the sensory score of the different extruded products. The final and optimized formulation of composite flour will be selected for the preparation of extruded product.

Table 7.1. Treatment details for optimization of flour proportion.

Treatment No.	Defatted peanut flour (%)	Amaranth flour (%)	Barnyard flour (%)	Tapioca pearls flour (%)	Total
1	13.53	49.33	14.90	22.24	100.00
2	10.00	39.43	10.00	40.57	100.00
3	29.05	10.00	37.19	23.76	100.00
4	24.56	24.79	25.85	24.81	100.00
5	50.00	10.00	30.00	10.00	100.00
6	10.00	10.00	30.00	50.00	100.00
7	30.00	50.00	10.00	10.00	100.00
8	24.56	24.79	25.85	24.81	100.00
9	39.00	10.00	10.00	41.00	100.00
10	25.37	14.63	50.00	10.00	100.00
11	39.00	10.00	10.00	41.00	100.00
12	25.37	14.63	50.00	10.00	100.00
13	24.56	24.79	25.85	24.81	100.00
14	10.00	10.00	50.00	30.00	100.00
15	35.54	22.65	31.82	10.00	100.00
16	50.00	30.00	10.00	10.00	100.00
17	10.00	28.50	43.34	18.17	100.00
18	24.56	24.79	25.85	24.81	100.00
19	19.45	20.55	10.00	50.00	100.00
20	10.00	47.03	32.97	10.00	100.00

- **Optimization of processing conditions for development of extruded product suitable for fasting**

  Response Surface Methodology (RSM) will be used for designing the experiments (Khuri and Cornell, 1987). A Central Composite Rotatable Design (CCRD) with 3 variables each at 5 levels will be employed to get the treatment details.

Table 7.2 : Coded and uncoded values of independent parameters to be used in the optimization of processing condition for the preparation of extruded product

Parameters	Code	Coded and Uncoded value				
		-1.682	**-1**	**0**	**+1**	**+1.682**
Moisture content (%)	(X_1)	12	13.22	15	16.78	18
Screw speed (rpm)	(X_2)	200	220	250	280	300
Die head temperature (°C)	(X_3)	90	102	120	138	150

Table 7.3 : Treatment combinations as per the central composite rotatable design for preparation of extruded product.

Treatment No.	Coded			Uncoded		
	X_1	X_2	X_3	Moisture (%)	Screw speed (rpm)	Die head temperature (°C)
1	-1	-1	-1	13.22	220	102
2	1	-1	-1	16.78	220	102
3	-1	1	-1	13.22	280	102
4	1	1	-1	16.78	280	102
5	-1	-1	1	13.22	220	138
6	1	-1	1	16.78	220	138
7	-1	1	1	13.22	280	138
8	1	1	1	16.78	280	138
9	-1.68	0	0	12.00	250	120
10	1.68	0	0	18.00	250	120
11	0	-1.68	0	15.00	200	120
12	0	1.68	0	15.00	300	120
13	0	0	-1.68	15.00	250	90
14	0	0	1.68	15.00	250	150
15	0	0	0	15.00	250	120
16	0	0	0	15.00	250	120
17	0	0	0	15.00	250	120
18	0	0	0	15.00	250	120
19	0	0	0	15.00	250	120
20	0	0	0	15.00	250	120

❖ **Observations to be recorded**

Sr. No.	Parameter	Method	Reference
1. Machine parameters (Twin screw extruder)			
1	Torque (Nm)	Digital torque meter	David *et al.* (2016)
2	Mass flow rate (g/min)	$\frac{\text{Weight of sample collected}}{\text{Time taken to collect sample (seconds)}}$	Deshpande and Poshadri (2011)
2. Physical Parameters of extruded product			
1	Bulk density (g/ml)	$\frac{\text{Weight of extrudates}}{\text{Volume extrudates}} X\ 100$	Anderson *et al.* (1969)
2	Expansion ratio (%)	$\frac{\text{Extrudate diameter}}{\text{Die diameter}} X\ 100$	Fan *et al.* (1996)
3. Biochemical parameters of extruded product			
1	Moisture content (%)	Hot air oven method	AOAC (2005)
2	Carbohydrate (%)	Phenol sulphuric acid method	AOAC (1965)

3	Protein (%)	Micro kjeldahl method	AOAC (1965)
4	Fat (%)	Soxhlet method	AOAC (2005)
5	Ash ((%)	muffle furnace	AOAC (2005)
6	Calorific value	(carbohydrates × 4 kcal) + (protein × 4 kcal) + (fat × 9 kcal)	Saini and Yadav (2018)
4. Functional Parameters			
1	Water solubility index (%)	$\frac{\text{Weight of dissolved solid in supernatant}}{\text{Weight of dry solids}} X\ 100$	Anderson *et al.* (1969)
2	Water absorption index (%)	$\frac{\text{Weight of sediment}}{\text{eight of dry solids}} X100$	Anderson *et al.* (1969)
3	Hardness(%)	Texture analyser	Ding *et al.* (2005)
5. Sensory parameters			
1	Appearance	9-point hedonic scale method (Amerine *et al.*, 1965)	
2	Colour		
3	Taste		
4	Crispness		
5	Overall acceptability		

❖ **Statistical Analysis**

The effect of three independent variables, X_1(Moisture Content), X_2(Screw speed) and X_3(Die head temperature), on different response variables will be evaluated by using the RSM. A Central Composite Rotatable Design (CCRD) of 3 variables each at five levels with 6 centre point combinations will be employed (1) to study the main effect of parameters, (2) to create models between the variables, and (3) to determine the effect of these variables to optimize the selected response variables. The statistical analysis of the experimental data will be carried out to observe the significance of the effect of selected process parameters on the various responses. Design Expert software 'DE-10' will be used for regression and graphical analysis of the data (Stat-Ease, 2000). The optimum values of the selected process parameters will be obtained by solving the regression equation and by analysing the response surface contour plots (Khuri and Cornell, 1987).

Possible outputs :

i. No any fasting snack product is available in the market. The new peanut based extruded product along with other food materials which is suitable for fasting will be developed.
ii. Protein content in the extruded product will be improved due to blending of peanut flour. Other food materials like amaranth, barnyard millet and tapioca pearl are also very nutritious and suitable for preparation of extruded product. The new process will develop the fasting snack product with more nutritional value in comparison to commercially available extruded products.
iii. The flour proportion of different food materials will be optimized to prepare the fasting snack product with good sensory characteristics.
iv. The process parameters for the preparation of peanut flour based fasting extruded product will be optimized.
v. The proposed process technology will suggest the proper byproduct utilization of peanut for the preparation of value added product.

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12. Financial Implications (in Lakhs) : Rs. 32.32 lakhs

(A) Financed by the institute

12.1 Manpower (Salaries / Wages)

S. No.	Staff Category	Man months	Cost
1.	Scientific	23	30,00,000
2.	Technical	5	2,00,000
3.	Supporting	--	--
4.	SRFs/RAs	--	--
5.	Contractual	--	--
	Total	28	32,00,000

12.2 Research/Recurring Contingency

S. No.	Item	Year(1)	Year (2)	Year (3)…	Total
1.	Consumables	10000	10000	--	20000
2.	Travel	5000	--	--	5000
3.	Field Preparation/ Planting/ Harvesting (Man-days/costs)	--	--	--	--
4.	Inter-cultivation & Dressing (Man-days/costs)	--	--	--	--
5.	Animal/Green house/Computer Systems/Machinery Maintenance	2000	--	--	2000
6.	Miscellaneous(Other costs)	5000	--	--	5000
	Total(Recurring)	22000	10000	--	32000

Justification : --

12.3 Non-recurring (Equipment)

S. No.	Item	Year (1)	Year (2)	Year (3)…	Total
1.		--	--	--	--
2.		--	--	--	--
	Total (Non-recurring)	--	--	--	--

Justification : --

12.4 Any Other Special Facility required (including cost)

12.5 Grand Total (12.1 to 12.4)

Item	Year (1)	Year (2)	Year (3)	Total
Grand Total	16,22,000	16,10,000	--	32,32,000

(B) Financed by an organization other than the Institute (if applicable) : No

- Name of Financing Organization : NA

- Total Budget of the Project :
- Budget details

S. No.	Item	Year(1)	Year(2)	Year (3)…	Total
1	Recurring Contingency				
	Travelling Allowance	--	--	--	--
	Workshops	--	--	--	--
	Contractual Services/ Salaries	--	--	--	--
	Operational Cost	--	--	--	--
	Consumables	--	--	--	--
2	Non - Recurring Contingency				
	Equipment	--	--	--	--
	Furniture	--	--	--	--
	Vehicle	--	--	--	--
	Others (Miscellaneous)	--	--	--	--
3	HRD Component				
	Training	--	--	--	--
	Consultancy	--	--	--	--
4	Works (i) New (ii) Renovation	--	--	--	--
5	Institutional Charges				

13. Expected Output : Process will be standardised for preparation of peanut sauce.

14. Expected Benefits and Economic Impact

i. No any fasting snack product is available in the market. The new peanut based extruded product along with other food materials which is suitable for fasting will be developed.

ii. Protein content in the extruded product will be improved due to blending of peanut flour. Other food materials like amaranth, barnyard millet and tapioca pearl are also very nutritious and suitable for preparation of extruded product. The new process will develop the fasting snack product with more nutritional value in comparison to commercially available extruded products.

iii. The flour proportion of different food materials will be optimized to prepare the fasting snack product with good sensory characteristics.

iv. The process parameters for the preparation of peanut flour based fasting extruded product will be optimized.

v. The proposed process technology will suggest the proper byproduct utilization of peanut for the preparation of value added product.

15. Risk Analysis

16. Signature

Project Leader Co-PI-I Co-PI-II

17. Signature of HoD

18. Signature of JD (R)/ Director

ANNEXURE - III

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

CHECKLIST FOR SUBMISSION OF RPP-I

(Refer for Guidelines ANNEXURE-XI(C))

1. Project Title : . Development of protein enriched Ready-to-Eat extruded product ideal for fasting by supplementing defatted peanut flour.

2. Date of Start & Duration : Date of Start: 01-03-2024
   Likely Date of Completion : 31-03-2025

3. Institute Project [√] or Externally Funded [ ]

4. Estimated Cost of the Project : 32.32 lakh

5. Project Presented in the Divisional/Institutional Seminar? ~~Yes~~ / No

6. Have suggested modifications incorporated? ~~Yes~~ / No

7. Status Report enclosed Yes / ~~No~~

8. Details of work load of investigators in approved ongoing projects:

Project Leader				Co-PI – I				Co-PI – II…
Proj. Code.	% Time spent	Date of start	Date of compl-etion	Proj. Code.	% Time spent	Date of start	Date of completion	………

9. Work Plan/Activity Chart enclosed Yes / ~~No~~

10. Included in Institute Plan Activity Yes / ~~No~~

11. Any previous Institute/Adhoc/Foreign aided projects on similar lines? Yes / ~~No~~

12. New equipment required for the project ~~Yes~~ / No

13. Funds available for new equipment ~~Yes~~ / No

14. Signatures

Project Leader   Co-PI-I   Co-PI-II   Co-PI–n

HOD/PD/I/c

ANNEXURE - IV

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

APPRAISAL BY THE PME CELL OF RPP-I

(Refer for Guidelines ANNEXURE-XI (D))

1. Institute Name
2. Project Title Development of protein enriched Ready-to-Eat extruded product ideal for fasting by supplementing defatted peanut flour.
3. On scale 1-10 give score to (a) to (j)

(a)	Relevance of research questions	☐
(b)	Addressing priority of the institute and/or National priority	☐
(c)	New innovativeness expected in the study	☐
(d)	Appropriateness of design/techniques for the questions to be answered	☐
(e)	Elements of bias addressed in the study	☐
(f)	Adequacy of scientist(s) time allocation	☐
(g)	Extent of system review and meta analysis	☐
(h)	Effective control to experiments	☐
(i)	Economic evaluation and cost efficiency analysis	☐
(j)	How appropriately the expected output answers the questions being addressed in the specific subject matter/area (Basic/Applied/Translational/Others)?	☐
	***Total Score out of 100**	

* The score obtained is suggestive of the overall quality ranking of the project

4. Was there any other project carried in the past in the same area/topic?

Yes ☐ No ☐

If yes, list the project numbers.

5. Signature of PME Cell Incharge

NEW INVESTIGATION – IV

ANNEXURE - I

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

PROFORMA FOR PREPARATION OF STATUS REPORT

FOR PROPOSAL OF A NEW RESEARCH PROJECT

(Refer for Guidelines ANNEXURE-XI(A))

1. **Institute Name :** College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh
2. **Title of the project :** Development of millet based extruded product supplemented with defatted peanut flour.
3. **Type of research project:** Basic/~~Applied/Extension/Farmer Participatory/Other~~ (specify)
4. **Genesis and rationale of the project :**

The increasing amount of time spent away from home has led to an increase in snacking. Consumers nowadays are becoming more and more aware of the concept of convenience and healthy foods. Owing to the changes in the life styles, economic status and health issues, foods are expected to meet many challenges in life. People are moving towards foods that not only prevent nutritional deficiency but also offer long term prevention from chronic diseases. This changing view and perception about food is highly influencing the consumption patterns. Expanded products like snacks and breakfast cereals are very popular today because of their crunchy texture, which arises from the honeycomb structure imparted to the material during extrusion. Extrusion is an ideal process that is used to make a wide range of snack and breakfast cereal products.

5. **Knowledge/Technology gaps and justification for taking up the present project including the questions to be answered :**

Pearl millet (*Pennisetum glaucum* L.) is one of the oldest cereals known to human being and consumed in various parts of the world as a staple food since hundreds of years back (Deepak *et al.,* 2012). It has been one of the major food sources for millions of people, especially those who live in hot, dry regions of the world other than wheat and maize. In contrast, millet is the major food sources of protein for billions of people in Africa and Asia. Millet has been reported to have many nutritional as well as therapeutic properties (Amadou *et al.,* 2013, Sarita and Singh, 2016). Nutritionally pearl millet is on a par or even superior to other cereals such as rice, maize and wheat with respect to energy value, proteins, fat and minerals. Various macronutrients like amino acids, vitamins, minerals, dietary fibers and antioxidants present in a more balanced ratio in a pearl millet than in other cereals. It makes an important contribution to human diet due to high levels of calcium, iron, zinc, lipids and high-quality proteins. The level of stored energy in pearl millet is approximately equal to that of maize. The most prominent feature of pearl millet is relatively higher lipid content, which gives more energetic feed than maize, wheat or sorghum.

The partially defatted peanut flour produced in the peanut processing industries is a very valuable by product containing about 60% protein. Further, the creamy white colour of this flour makes it a very suitable ingredient in the production of many value added products. The idea of production of nutrient dense ready-to-eat extruded snacks by blending of millets and defatted peanut flour appears to be a very attractive strategy to improve the nutritional status of the snack foods. Very little information is there on use of millet and defatted peanut flour in the extrusion process. Further, the combine effect of various operational and feed parameters in relation to product quality have not been investigated and standardized so far. Considering all these facts, the research work is undertaken to develop the millet based extruded product supplemented with defatted peanut flour.

6. Critical review of present status of the technology at national and international levels along with complete references :

Davara *et al.* (2022) developed the extruded snack products by blending of corn flour and defatted peanut flour using twin screw extruder. The combined effects of feed moisture content, defatted peanut flour content, die head temperature and screw speed on the important physical (expansion ratio) and functional (water absorption index, water holding capacity and water solubility index) properties of extrudates were studied. The Response Surface Methodology (RSM) was used in designing the experiment. Since, the defatted peanut flour is poor in starch content, the flour content restricted the gelatinization and limited the expansion of the product. Defatted peanut flour was found to be suitable for the preparation of extruded snacks with the appropriate blending corn flour as a base material. The optimum treatment condition was found as 13% feed moisture content, 26% defatted peanut flour, 135 °C die head temperature and 250 rpm screw speed for the production of extruded product by blending of defatted peanut flour with corn flour.

Yağcı and Göğüoş (2008) investigated the effects of extrusion conditions including moisture content (12–18%), temperature (150–175 °C), screw speed (200–280 rpm), and change in feed composition, durum clear flour (8–20%), partially defatted hazelnut flour (PDHF) (5–15%) and fruit waste (3–7%) contents on the physical and functional characteristics of the extruded snack food based on rice grit in combination with fruit waste, durum clear flour and PDHF. Response variables were bulk density, porosity, water absorption and water solubility indices and sensory properties of the extruded snacks. The product responses were most affected by changes in PDHF content and to a lesser extent by fruit waste content. Increasing PDHF content caused increase in bulk density and water solubility index, but decrease in porosity and water absorption index of the extruded snacks. Changing process conditions affected the physical and functional properties of produced snacks. The sensory evaluation of extrudates suggests that extrusion of PDHF, fruit waste and durum clear flour in combination with rice grit can produce acceptable extruded snack.

Semasaka *et al*. (2010) formulated blends of 44% corn flour, 36% millet flour and 20% soybean flour were performed using DPSv 11.50 software. The explanatory variables used were temperature (for the feeding, mixing, cooking and die zones), rolling speed, feeding speed and moisture content of the samples. The response 10 variables were bulk density, WAI, WSI, pasting properties, thermal analysis, swelling power and the colour of the extrudates. He found that the better factors and levels showed that the temperature 80, 110, 140 and 170 °C, rolling speed of 110 rpm, feeding speed of 37 g/min and moisture content varies from 25 - 30% are the best for the extrusion of that formulation.

Ying and Xiao-dong (2010) prepared the frozen noodles using blends of wheat and defatted peanut flours containing 100%, 95%, 90%, 85% and 80% of wheat flour and 0, 5%, 10%, 15% and 20% of defatted peanut flour (DPF). The optimum mixing ratio for wheat and defatted peanut flours, water amount and salt amount for improved sensory evaluation of processed noodles were determined by orthogonal array design to be 10:90, 40% and 2.5%, respectively. The analysis of the quality of DPF frozen noodles showed the gluten content, pasting viscosities and texture properties decreased, while the boiling loss rate increased with increasing DPF amount. Therefore, added DPF may soften the texture of noodles. Defatted peanut nutritive noodles could be acceptable to children and the elderly due to their good eating quality and high nutritional value.

Seth and Rajamanickam (2012) examined the development of extruded snacks using sorghum, soy, rice and millet blend. Formulation was optimized using RSM. Effects of amount of ingredients on the physical properties like expansion ratio, bulk density, WAI and WSI of snacks were investigated. Significant regression models that explained the effects of different percentages of ragi, sorghum and soy on all response variables were determined. The coefficients of determination were higher than 0.90 of all the response variables. Based on the given criteria for optimisation, the basic formulation for production of millet-based extruded snack with desired sensory quality was obtained by incorporating with 42.03% ragi, 30% rice, 14.95% sorghum and 12.97% soy.

7. Expertise available with the investigating group/Institute

The PI & Co-PI of project is having enough experience of working in the field of Processing and Food Engineering. Both are the experts in the field of Processing and Food Engineering. The PI is quite capable and qualified to handle this project. The facility and man power is available in the institute for to conduct the process activities in the laboratory.

8. Brief note on Proprietary/Patent Perspective (for projects related to technology development)/Ethics/Animal Welfare/Bio Safety Issues

- No issues are there on these aspects.

9. (a) Expected output

i. The new millet and peanut based extruded product will be made available to the food industries.
ii. Protein content in the millet based extruded product will be improved due to supplementation of defatted peanut flour. Pearl millet is also superior to other cereals such as rice, maize and wheat with respect to energy value, proteins, fat and minerals
iii. The new process will develop the millet based extruded product with more nutritional value in comparison to commercially available extruded products.
iv. The flour proportion of different food materials will be optimized to prepare the extruded snack product with good sensory characteristics.
v. The process parameters for the preparation of millet and peanut flour based extruded product will be optimized.
vi. The proposed process technology will suggest the proper byproduct utilization of peanut for the preparation of value added product.

(b) Clientele/Stake holders (including economic and socio aspects)

- Millet and Peanut growers
- Millet and Peanut processors
- Snack manufacturers
- Consumers

10. Signatures

[Project Leader] [Co-PIs]

……

11. Comments and signature

[Head of Division]

ANNEXURE- II

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

RESEARCH PROJECT PROFORMA FOR INITIATION OF A RESEARCH PROJECT (RPP - I)

(Refer for Guidelines ANNEXURE-XI (B))

1. Institute Project Code (to be provided by PME Cell)
2. Project Title : Development of millet based extruded product supplemented with defatted peanut flour.
3. Key Words : Peanut flour, millet flour, extrusion, high protein, extruded product.
4. (a) Name of the Lead Institute : College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh.
   (b) Name of Division/ Regional Center/ Section : AICRP on PHET, Junagadh centre.
5. (a) Name of the Collaborating Institute(s) : --
   (b) Name of Division/ Regional Center/ Section of Collaborating Institute(s) : ---
6. Project Team(Name(s) and designation of PI, CC-PI and all project Co-PIs, with time proposed to be spent)

Sr. No.	Name, designation and institute	Status in the project (PI/CC-PI/ Co-PI)	Time to be spent (%)	Work components to be assigned to individual scientist
1.	Dr. P. R. Davara, Assistant Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	PI	75%	1. Review collection/literature survey 2. Designing of the experiment 3. Procurement of raw materials 4. Quality analysis of the raw materials 5. Experimental trials for the optimization of flour proportion of different ingredient food materials 6. Sensory analysis of extruded products prepared during preliminary trials for the optimization of flour proportion 7. Optimization of the flour proportion based on the data of sensory parameters obtained for the different extruded product 8. Laboratory trials for the preparation of peanut and millet based extruded product at the

				optimized flour proportion as per the experimental treatments 9. Physico-chemical and sensory analysis of the developed extruded products 10. Data collection and its analysis 11. Optimization of the processing parameters based on the experimental data 12. Report writing
2.	Dr. M. N. Dabhi, Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	Co-PI	25%	To assist the PI in carrying out the different activities of the project as and when needed

7. Priority Area to which the project belongs : Post Harvest Technology
(If not already in the priority area, give justification)

8. Project Duration: Date of Start: 01-03-2024 Likely Date of Completion **:** 31-03-2026

9. (a) Objectives

1. To optimize the blending ratio of pearl millet and defatted peanut flour for the preparation of extruded product based on sensory parameters.
2. To study the effect of different operational and feed parameters on different quality and sensory parameters of extruded products formulated through blending of pearl millet and defatted peanut flour.
3. To optimize the process parameters for the development millet based extruded product supplemented with defatted peanut flour.

(b) Practical utility

1. The new millet and peanut based extruded product will be made available to the food industries.
2. Protein content in the millet based extruded product will be improved due to supplementation of defatted peanut flour. Pearl millet is also superior to other cereals such as rice, maize and wheat with respect to energy value, proteins, fat and minerals
3. The new process will develop the millet based extruded product with more nutritional value in comparison to commercially available extruded products.
4. The flour proportion of different food materials will be optimized to prepare the extruded snack product with good sensory characteristics.
5. The process parameters for the preparation of millet and peanut flour based extruded product will be optimized.
6. The proposed process technology will suggest the proper byproduct utilization of peanut for the preparation of value added product.

10. Activities and outputs details

Objective wise	Activity	Month & Year of		Output monitorable target(s)	% to be carried out in different years			Scientist(s) responsible
		Start	Completion		1	2	..	
1.	Review collection/literature survey	March -24	Marh-24	1. To collect the data on utilization of pearl millet and defatted peanut flour in the production of extruded products. 2. To study the work done in the past	100%	--	--	Dr. P. R. Davara
2.	Designing of the experiment	March -24	Marh-24	Designing of the experiments as per the Response surface methodology for the following two aspects 1. Optimization of flour proportion of different food materials 2. Optimization of processing parameters	100%	--	-	Dr. P. R. Davara
3.	Procurement of raw materials	April-24	April-24	Raw materials like pearl millet flour and defatted peanut flour will be procured	100%	--	--	Dr. P. R. Davara
4.	Quality analysis of the raw materials	May-24	May-24	Physico-chemical characteristics of raw materials will be determined	100%	--	-	Dr. P. R. Davara

5.	Experimental trials for the optimization of flour proportion of different ingredient food materials	June-24	June-24	Preliminary trials will be carried out for the preparation of extruded product using flour of different raw materials selected for the project	100%	100 %	-	Dr. P. R. Davara
6.	Sensory analysis of extruded products prepared during preliminary trials for the optimization of flour proportion	June-24	June-24	The extruded product obtained after preliminary trials will be analysed for their sensory charactristics	--	100 %	--	Dr. P. R. Davara
7	Optimization of the flour proportion based on the data of sensory parameters obtained for the different extruded products	July-24	July-24	The data of sensory parameters will be analysed through Design Expert software to get the optimized flour proportion.		100 %		Dr. P. R. Davara
8	Laboratory trials for the preparation of peanut based extruded product at the optimized flour proportion as per the experimental treatments	Aug-24	Aug-24	Experimental trials will be carried out by taking the flour proportion at the optimized levels by varying the different processing parameters		100 %		Dr. P. R. Davara
9.	Physico-chemical and sensory analysis of the developed extruded products	Aug-24	Aug-24	Developed extruded products will be analysed for their physico-chemical and sensory quality	--	100 %	--	Dr. P. R. Davara

10.	Data collection and its analysis	Sept-24	Sept-24	The data of various physico-chemical and sensory parameters will be collected and statistically analysed	--	100 %	--	Dr. P. R. Davara, Dr. M. N. Dabhi
11.	Optimization of the processing parameters based on the experimental data	Oct-24	Nov-24	The data of physico-chemical and sensory parameters will be analysed through Design Expert software to get the optimized processing condition.		100 %		Dr. P. R. Davara, Dr. M. N. Dabhi
12.	Report writing	Dec-24	March-25	Compilation of collected data and preparation of report			100 %	Dr. P. R. Davara, Dr. M. N. Dabhi

11. Technical Programme (brief)

Justification :

The increasing amount of time spent away from home has led to an increase in snacking. Consumers nowadays are becoming more and more aware of the concept of convenience and healthy foods. Owing to the changes in the life styles, economic status and health issues, foods are expected to meet many challenges in life. People are moving towards foods that not only prevent nutritional deficiency but also offer long term prevention from chronic diseases. This changing view and perception about food is highly influencing the consumption patterns. Expanded products like snacks and breakfast cereals are very popular today because of their crunchy texture, which arises from the honeycomb structure imparted to the material during extrusion. Extrusion is an ideal process that is used to make a wide range of snack and breakfast cereal products.

Pearl millet (*Pennisetum glaucum* L.) is one of the oldest cereals known to human being and consumed in various parts of the world as a staple food since hundreds of years back. It has been one of the major food sources for millions of people, especially those who live in hot, dry regions of the world other than wheat and maize. In contrast, millet is the major food sources of protein for billions of people in Africa and Asia. Millet has been reported to have many nutritional as well as therapeutic properties. Nutritionally pearl millet is on a par or even. Various macronutrients like amino acids, vitamins, minerals, dietary fibers and antioxidants present in a more balanced ratio in a pearl millet than in other cereals. It makes an important contribution to human diet due to high levels of calcium, iron, zinc, lipids and high-quality proteins. The level of stored energy in pearl millet is approximately equal to that of maize. The most prominent feature of pearl millet is relatively higher lipid content, which gives more energetic feed than maize, wheat or sorghum.

The partially defatted peanut flour produced in the peanut processing industries is a very valuable by product containing about 60% protein. Further, the creamy white colour of this flour makes it a very suitable ingredient in the production of many value added products. The idea of production of nutrient dense ready-to-eat extruded snacks by blending of millets and defatted peanut flour appears to be a very attractive strategy to improve the nutritional status of the snack foods. Very little information is there on use of millet and defatted peanut flour in the extrusion process. Further, the combine effect of various operational and feed parameters in relation to product quality have not been investigated and standardized so far. Considering all these facts, the research work is undertaken to develop the millet based extruded product supplemented with defatted peanut flour.

Status (review) :

Davara *et al.* (2022) developed the extruded snack products by blending of corn flour and defatted peanut flour using twin screw extruder. The combined effects of feed moisture content, defatted peanut flour content, die head temperature and screw speed on the important physical (expansion ratio) and functional (water absorption index, water holding capacity and water solubility index) properties of extrudates were studied. The Response Surface Methodology (RSM) was used in designing the experiment. Since, the defatted peanut flour is poor in starch content, the flour content restricted the gelatinization and limited the expansion of the product. Defatted peanut flour was found to be suitable for the preparation of extruded snacks with the appropriate blending corn flour as a base material. The optimum treatment condition was found as 13% feed moisture content, 26% defatted peanut flour, 135 °C die head temperature and 250 rpm screw speed for the production of extruded product by blending of defatted peanut flour with corn flour.

Yağcı and Göğüoş (2008) investigated the effects of extrusion conditions including moisture content (12–18%), temperature (150–175 °C), screw speed (200–280 rpm), and change in feed composition, durum clear flour (8–20%), partially defatted hazelnut flour (PDHF) (5–15%) and fruit waste (3–7%) contents on the physical and functional characteristics of the extruded snack food based on rice grit in combination with fruit waste, durum clear flour and PDHF. Response variables were bulk density, porosity, water absorption and water solubility indices and sensory properties of the extruded snacks. The product responses were most affected by changes in PDHF content and to a lesser extent by fruit waste content. Increasing PDHF content caused increase in bulk density and water solubility index, but decrease in porosity and water absorption index of the extruded snacks. Changing process conditions affected the physical and functional properties of produced snacks. The sensory evaluation of extrudates suggests that extrusion of PDHF, fruit waste and durum clear flour in combination with rice grit can produce acceptable extruded snack.

Semasaka *et al.* (2010) formulated blends of 44% corn flour, 36% millet flour and 20% soybean flour were performed using DPSv 11.50 software. The explanatory variables used were temperature (for the feeding, mixing, cooking and die zones), rolling speed, feeding speed and moisture content of the samples. The response 10 variables were bulk density, WAI, WSI, pasting properties, thermal analysis, swelling power and the colour of the extrudates. He found that the better factors and levels showed that the temperature 80, 110, 140 and 170 °C, rolling speed of 110 rpm, feeding speed of 37 g/min and moisture content varies from 25 - 30% are the best for the extrusion of that formulation.

Seth and Rajamanickam (2012) examined the development of extruded snacks using sorghum, soy, rice and millet blend. Formulation was optimized using RSM. Effects of amount of ingredients on the physical properties like expansion ratio, bulk density, WAI and WSI of snacks were investigated. Significant regression models that explained the effects of different percentages of ragi, sorghum and soy on all response variables were determined. The coefficients of determination were higher than 0.90 of all the response variables. Based on the given criteria for optimisation, the basic formulation for production of millet-based extruded snack with desired sensory quality was obtained by incorporating with 42.03% ragi, 30% rice, 14.95% sorghum and 12.97% soy.

Objectives

1. To optimize the blending ratio of pearl millet and defatted peanut flour for the preparation of extruded product based on sensory parameters.
2. To study the effect of different operational and feed parameters on different quality and sensory parameters of extruded products formulated through blending of pearl millet and defatted peanut flour.
3. To optimize the process parameters for the development millet based extruded product supplemented with defatted peanut flour.

Technical programme

❖ Extruded product preparation

The procedure to be followed for the preparation of extruded product using twin screw extruder is presented in the process flow chart as given in Fig. 1.

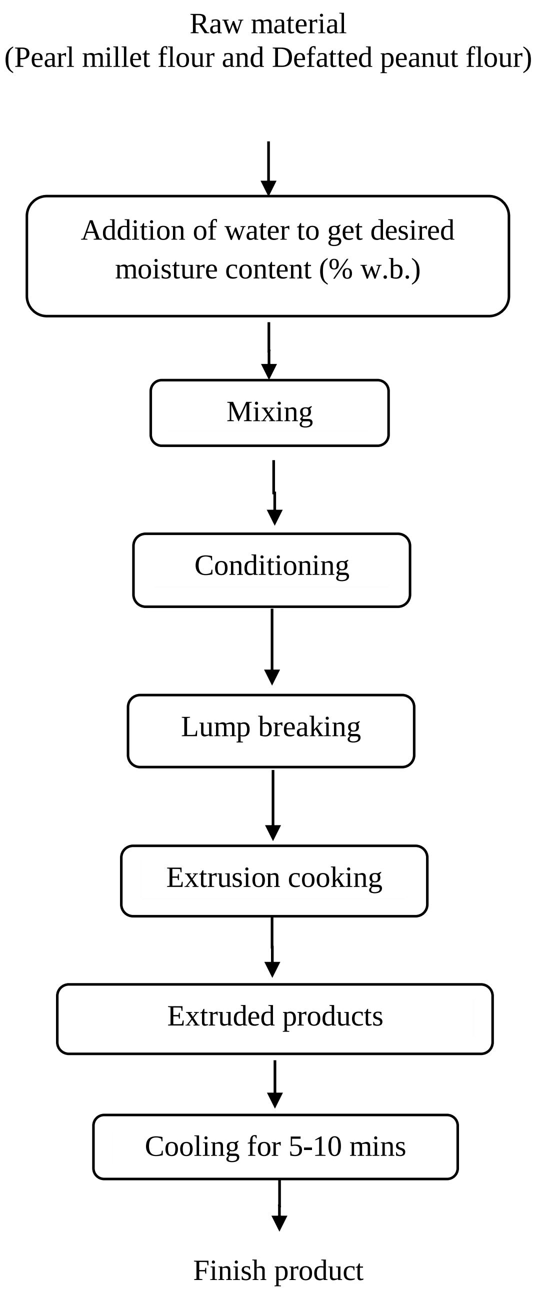

Fig. 8.1 : Process flow chart for preparation of extruded product.

❖ **Optimization of blending ratio of pearl millet and defatted peanut flour for the preparation of extruded product**

Experiment trials will be conducted to optimize the blending ratio of pearl millet and defatted peanut flour in the preparation of extruded product. The different proportions of these flours are to be mixed with each other as suggested by the Mixture Design of Response Surface Methodology (RSM) as given in the Table 1. The extruded products will be prepared by keeping the feeder temperature (60°C), barrel temperature (100°C), die temperature (135°C) and screw rpm (250 rpm) at constant level (Davara *et al.*, 2022). The extruded products as prepared by the different flour combinations will be evaluated for their sensory paraments (Appearance, Taste, Colour, Crispness and Overall Acceptability) using 9-point hedonic scale method. Finally, the blending ratio of pearl millet and defatted peanut flour will be optimized though RSM based on the sensory score of the different extruded products. The optimized formulation of composite flour will be selected for optimizing the process for the development millet based extruded product supplemented with defatted peanut flour.

Table 8.1 : Treatment details for optimization of flour proportion.

Treatment No.	Pearl millet flour (%)	Defatted peanut flour (%)	Total
1	36.67	63.33	100.00
2	63.33	36.67	100.00
3	90.00	10.00	100.00
4	10.00	90.00	100.00
5	10.00	90.00	100.00
6	30.00	70.00	100.00
7	70.00	30.00	100.00
8	90.00	10.00	100.00
9	90.00	10.00	100.00
10	50.00	50.00	100.00
11	10.00	90.00	100.00
12	50.00	50.00	100.00
13	50.00	50.00	100.00

- **Optimization of processing parameters for development of extruded product**

Response Surface Methodology (RSM) will be used for designing the experiments (Khuri and Cornell, 1987). A Central Composite Rotatable Design (CCRD) with 3 variables each at 5 levels will be employed to get the treatment details. The other constraints will be kept constant as under.

Die hole : Round opening
Feeder temp. : 60 °C
Barrel temp. : 100 °C
Feeder speed : 12 rpm
Length-to-diameter ratio : 20:1

- **Independent parameters :**

Table 8.2 : Coded and uncoded values of independent parameters to be used in the optimization of processing condition for the preparation of extruded product

Parameters	Code	Coded and Uncoded value				
		-1.682	-1	0	+1	+1.682
Moisture content (%)	(X_1)	12	13.22	15	16.78	18
Screw speed (rpm)	(X_2)	200	220	250	280	300
Die head temperature (°C)	(X_3)	90	102	120	138	150

Table 8.3 : Treatment combinations to be used in optimizing the process parameters for the development millet based extruded product supplemented with defatted peanut flour.

Treatment No.	Coded			Uncoded		
	X_1	**X_2**	**X_3**	**Moisture (%)**	**Screw speed (rpm)**	**Die head temperature (°C)**
1	-1	-1	-1	13.22	220	102
2	1	-1	-1	16.78	220	102
3	-1	1	-1	13.22	280	102
4	1	1	-1	16.78	280	102
5	-1	-1	1	13.22	220	138
6	1	-1	1	16.78	220	138
7	-1	1	1	13.22	280	138
8	1	1	1	16.78	280	138
9	-1.68	0	0	12.00	250	120
10	1.68	0	0	18.00	250	120
11	0	-1.68	0	15.00	200	120
12	0	1.68	0	15.00	300	120
13	0	0	-1.68	15.00	250	90
14	0	0	1.68	15.00	250	150
15	0	0	0	15.00	250	120
16	0	0	0	15.00	250	120
17	0	0	0	15.00	250	120
18	0	0	0	15.00	250	120
19	0	0	0	15.00	250	120
20	0	0	0	15.00	250	120

❖ **Observations to be recorded**

Sr. No.	**Parameter**	**Method**	**Reference**
1. Machine parameters (Twin screw extruder)			
1	Torque (Nm)	Digital torque meter	David *et al.* (2016)
2	Mass flow rate (g/min)	$\frac{\text{Weight of sample collected}}{\text{Time taken to collect sample (seconds)}}$	Deshpande and Poshadri (2011)
2. Physical Parameters of extruded product			
1	Bulk density (g/ml)	$\frac{\text{Weight of extrudates}}{\text{Volume extrudates}} X\ 100$	Anderson *et al.* (1969)
2	Expansion ratio (%)	$\frac{\text{Extrudate diameter}}{\text{Die diameter}} X\ 100$	Fan *et al.* (1996)
3. Biochemical parameters of extruded product			
1	Moisture content (%)	Hot air oven method	AOAC (2005)
2	Carbohydrate (%)	Phenol sulphuric acid method	AOAC (1965)
3	Protein (%)	Micro kjeldahl method	AOAC (1965)
4	Fat (%)	Soxhlet method	AOAC (2005)
5	Ash ((%)	muffle furnace	AOAC (2005)

6	Calorific value	(carbohydrates × 4 kcal) + (protein × 4 kcal) + (fat × 9 kcal)	Saini and Yadav (2018)
4. Functional Parameters			
1	Water solubility index (%)	$\frac{\text{Weight of dissolved solid in supernatant}}{\text{Weight of dry solids}} X\ 100$	Anderson *et al.* (1969)
2	Water absorption index (%)	$\frac{\text{Weight of sediment}}{\text{eight of dry solids}} X100$	Anderson *et al.* (1969)
3	Hardness(%)	Texture analyser	Ding *et al.* (2005)
5. Sensory parameters			
1	Appearance	9-point hedonic scale method (Amerine *et al*., 1965)	
2	Colour		
3	Taste		
4	Crispness		
5	Overall acceptability		

❖ **Statistical Analysis**

The effect of three independent variables, X_1(Moisture Content), X_2(Screw speed) and X_3(Die head temperature), on different response variables will be evaluated by using the RSM. A Central Composite Rotatable Design (CCRD) of 3 variables each at five levels with 6 centre point combinations will be employed (1) to study the main effect of parameters, (2) to create models between the variables, and (3) to determine the effect of these variables to optimize the selected response variables. The statistical analysis of the experimental data will be carried out to observe the significance of the effect of selected process parameters on the various responses. Design Expert software 'DE-10' will be used for regression and graphical analysis of the data (Stat-Ease, 2000). The optimum values of the selected process parameters will be obtained by solving the regression equation and by analysing the response surface contour plots (Khuri and Cornell, 1987).

Possible outputs :

- The new millet and peanut based extruded product will be made available to the food industries.
- Protein content in the millet based extruded product will be improved due to supplementation of defatted peanut flour. Pearl millet is also superior to other cereals such as rice, maize and wheat with respect to energy value, proteins, fat and minerals
- The new process will develop the millet based extruded product with more nutritional value in comparison to commercially available extruded products.
- The flour proportion of different food materials will be optimized to prepare the extruded snack product with good sensory characteristics.
- The process parameters for the preparation of millet and peanut flour based extruded product will be optimized.
- The proposed process technology will suggest the proper byproduct utilization of peanut for the preparation of value added product

References :

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12. **Financial Implications (in Lakhs) : Rs. 32.32 lakhs**

(A) Financed by the institute

12.1 Manpower (Salaries / Wages)

S. No.	Staff Category	Man months	Cost
1.	Scientific	23	30,00,000
2.	Technical	5	2,00,000
3.	Supporting	--	--
4.	SRFs/RAs	--	--
5.	Contractual	--	--
	Total	28	32,00,000

12.2 Research/Recurring Contingency

S. No.	Item	Year(1)	Year (2)	Year (3)…	Total
19.	Consumables	10000	10000	--	20000
13.	Travel	5000	--	--	5000
14.	Field Preparation/ Planting/ Harvesting (Man-days/costs)	--	--	--	--
15.	Inter-cultivation & Dressing (Man-days/costs)	--	--	--	--
16.	Animal/Green house/Computer Systems/Machinery Maintenance	2000	--	--	2000
17.	Miscellaneous(Other costs)	5000	--	--	5000
	Total(Recurring)	22000	10000	--	32000

Justification : --

12.3 Non-recurring (Equipment)

S. No.	Item	Year (1)	Year (2)	Year (3)…	Total
1.		--	--	--	--
2.		--	--	--	--
	Total (Non-recurring)	--	--	--	--

Justification : --

12.4 Any Other Special Facility required (including cost)

12.5 Grand Total (12.1 to 12.4)

Item	Year (1)	Year (2)	Year (3)	Total
Grand Total	16,22,000	16,10,000	--	32,32,000

(B) Financed by an organization other than the Institute (if applicable) : No

- Name of Financing Organization : NA
- Total Budget of the Project :
- Budget details

S. No.	Item	Year(1)	Year(2)	Year (3)…	Total
1	Recurring Contingency				
	Travelling Allowance	--	--	--	--
	Workshops	--	--	--	--
	Contractual Services/ Salaries	--	--	--	--
	Operational Cost	--	--	--	--
	Consumables	--	--	--	--
2	Non - Recurring Contingency				
	Equipment	--	--	--	--
	Furniture	--	--	--	--
	Vehicle	--	--	--	--
	Others (Miscellaneous)	--	--	--	--
3	HRD Component				
	Training	--	--	--	--
	Consultancy	--	--	--	--
4	Works (i) New (ii) Renovation	--	--	--	--
5	Institutional Charges				

13. Expected Output : Process will be standardised for preparation of millet and peanut flour based extruded product.

14. Expected Benefits and Economic Impact
    - The new extruded product will be developed using defatted peanut flour.
    - Protein content in the peanut flour extruded product will be improved. It will be more nutritional in comparison to commercially available extruded products.
    - The proposed process technology will suggest the proper byproduct utilization of peanut for the preparation of value added product.
    - The process parameters for the preparation of peanut flour based extruded product will be standardized.

18. Risk Analysis

19. Signature

Project Leader Co-PI-I Co-PI-II

20. Signature of HoD

21. Signature of JD (R)/ Director

ANNEXURE - III

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

CHECKLIST FOR SUBMISSION OF RPP-I

(Refer for Guidelines ANNEXURE-XI(C))

1. Project Title : Development of millet based extruded product supplemented with defatted peanut flour.

2. Date of Start & Duration : Date of Start: 01-03-2024
   Likely Date of Completion : 31-03-2026

3. Institute Project [√] or Externally Funded [ ]

4. Estimated Cost of the Project : 32.32 lakh

5. Project Presented in the Divisional/Institutional Seminar? ~~Yes~~ / No

6. Have suggested modifications incorporated? ~~Yes~~ / No

7. Status Report enclosed Yes / ~~No~~

8. Details of work load of investigators in approved ongoing projects:

Project Leader				Co-PI – I				Co-PI – II…
Proj. Code.	% Time spent	Date of start	Date of compl-etion	Proj. Code.	% Time spent	Date of start	Date of completion	………

9. Work Plan/Activity Chart enclosed Yes / ~~No~~

10. Included in Institute Plan Activity Yes / ~~No~~

11. Any previous Institute/Adhoc/Foreign aided projects on similar lines? Yes / ~~No~~

12. New equipment required for the project ~~Yes~~ / No

13. Funds available for new equipment ~~Yes~~ / No

14. Signatures

Project Leader Co-PI-I Co-PI-II Co-PI–n

HOD/PD/I/c

ANNEXURE - IV

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

APPRAISAL BY THE PME CELL OF RPP-I

(Refer for Guidelines ANNEXURE-XI (D))

1. Institute Name
2. Project Title
3. On scale 1-10 give score to (a) to (j)

(a)	Relevance of research questions	☐
(b)	Addressing priority of the institute and/or National priority	☐
(c)	New innovativeness expected in the study	☐
(d)	Appropriateness of design/techniques for the questions to be answered	☐
(e)	Elements of bias addressed in the study	☐
(f)	Adequacy of scientist(s) time allocation	☐
(g)	Extent of system review and meta analysis	☐
(h)	Effective control to experiments	☐
(i)	Economic evaluation and cost efficiency analysis	☐
(j)	How appropriately the expected output answers the questions being addressed in the specific subject matter/area (Basic/Applied/Translational/Others)?	☐
	***Total Score out of 100**	

* The score obtained is suggestive of the overall quality ranking of the project

4. Was there any other project carried in the past in the same area/topic?

   Yes ☐ No ☐

   If yes, list the project numbers.

5. Signature of PME Cell Incharge

<u>NEW INVESTIGATION – V</u>

ANNEXURE - I

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

PROFORMA FOR PREPARATION OF STATUS REPORT

FOR PROPOSAL OF A NEW RESEARCH PROJECT

(Refer for Guidelines ANNEXURE-XI(A))

1. **Institute Name :** College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh.

2. **Title of the project :** Optimization of process parameters for protein extraction from defatted peanut flour through fermentation.

3. **Type of research project:** Basic/~~Applied/Extension/Farmer Participatory/Other~~ (specify)

4. **Genesis and rationale of the project :**

Groundnut (*Arachis hypogea* L.) being most valuable oilseed crop in world, known as "King of oilseeds", is a low priced commodity which is rich in nutrition. India has good performance in peanut area, production and yield i.e. 6.09 MH, 10.21 MT and 1676 kg./hectare respectively in 2020-21. In India, gujarat is leading state in peanut area, production and yield i.e. 2.16 MH, 4.13 MT and 1908 kg./hectare respectively (Agricultural Statistics at a Glance - 2021).

Proteins are one of the major essential nitrogen containing nutrients required by human beings for normal growth and maintenance (Jay *et al*., 2004). Proteins are mainly obtained from animal and plant sources. Animal protein sources include meat, fish, poultry, egg, milk and milk products while vegetable sources include pulses, oilseeds, legumes, fruits and vegetables (www.wikipedia.org/proteinnutrient). On comparison of animal and vegetable sources of protein, researchers concluded that animal sources are high in cholesterol which are related to occurrence of heart diseases and increased blood pressures. Animal sources are deficient in fiber which increases faecal weight and its absence in diet causes constipation problems. Plant sources are thus free from harmful cholesterols and also provides important minerals *viz.*, iron, magnesium and calcium whereas animal proteins are deficient in many mineral components. Also plant proteins serve as abundant sources of antioxidants and are easy to digest, free from certain allergens thus giving additional reasons for its mass use over costlier animal proteins to feed population to solve problems of protein deficiencies in developing countries (Zhang *et al.*, 2014).

Peanut is the oilseed which is high in fat content, good in protein content, high in energy content, average in carbohydrate content and good in fiber content. It also contains many other functional compounds like fibers, polyphenols, antioxidants, vitamins and minerals. (Kathleen, 2015). Peanuts contain all the 20 amino acids in variable proportions and is the biggest source of the protein called "arginine" (USDA, 2014). After the peanut oil is extracted, the protein content in the cake can reach 50% (Zhao *et al*. 2011). Commercially it is used mainly for oil production. Apart from oil, peanuts are widely used for production of peanut butter, confections, roasted peanuts, snack products, extenders in meat product formulation, peanut sauce, peanut flour, peanut milk, peanut beverage, peanut snacks (salted and sweet bars) and peanut cheese analogs (Arya *et al*., 2016).

The partially defatted peanut flour produced after peanut milk preparation has not found any specific use in the food processing. This flour contains about 30% protein. Peanut protein has been isolated using various methods i.e. extraction-isoelectric precipitation (AEIEP), salt extraction-dialysis, micellar precipitation and aqueous extraction (pH > 7) (Lam, A.C.Y.*et al* 2018). Nutritional, sensory and technological properties of pea proteins can be influenced by the extraction process (Gao, Z. *et al*., 2020).That is why food researchers and the industry are constantly trying to develop new cost-effective and safe extraction methods with optimal extractability leading to adequate techno-functional and sensory properties (Stone, A.K. *et al*, 2015).

Apart from conventional methods, physical modification or pretreatments like high power sonication (HPS) can be used as a potential alternative method for the extraction of proteins as well as modification. The combination of physical treatment and fermentation with lactic acid producing bacteria will change the molecular structure and functions, reduce or eliminate anti-nutritional factors and hence improve the quality of protein ingredient (Kiers et al., 2000 ; Ojokoh et al., 2011). HPS disrupts plant metrices and facilitates the extraction of protein, carbohydrates and other bioactive compounds (Vilkhu et al., 2008). HPS can release carbohydrates and sugars which can be utilized in fermentation to produce hydrolytic enzymes and thus, modify substrates. Fermentation with lactic acid bacteria is a traditional technique that serves as a practical method for food preservation (Matejcekova, Z. *et al*., 2019). It has been used to enhance the bio accessibility and bioavailability of nutrients to improve the organoleptic properties and shelf life of various legume proteins (Schlegel, K.*et al.*, 2019). Fermentation consists of modifying food by microorganisms (bacteria, molds and yeasts) that grow and consume part of the substrates and enrich it with the products of their metabolism However, selection of the right microorganism is necessary, since some microorganisms including yeasts and molds might concern food safety. Lactic acid bacteria (LAB) with the generally recognized as safe (GRAS) status are of great interest in food fermentation (Klupsaite, D. *et al*., 2017). They are known for contributing to the improvement of desired sensory properties and improvement of food's aroma (Coda, R. *et al*., 2015).

LAB have been increasingly used for legume fermentation in the last decade. However, its effect is highly related to the legume type, LAB strain and fermentation conditions (Rui, X. *et al.*, 2017). Lactic acid fermentation can affect the structure and content of legume protein. This can be attributed to the proteolytic activity of bacteria mechanism during fermentation, by which the polypeptide chain is broken down, and new polypeptides with a lower molecular weight are formed (Lampart-Szczapa*et al*., 2006). The changes in protein conformation and structure alter the functionality and nutritional properties of the final products (Sozer, N. *et al*., 2019)

The LAB species such as *Streptococcus thermophilus*, *Lactobacillus delbrueckii subsp. bulgaricus*, *Lactobacillus acidophilus*, *Lactobacillus helveticus* and *Lactobacillus plantarum* have been frequently reported for their positive effects on the organoleptic properties of legume protein (Yousseef, M. *et al*., 2016).The development of LAB during pea protein fermentation helps the improvement of aroma and flavor by either reducing the occurrence of compounds responsible for off-flavor or masking undesirable green notes (Ben-Harb, S. *et al*., 2019). LAB fermentation is also an effective way for partial or complete degradation of anti-nutritional factors and improvement of protein bioavailability and digestibility (Czarnecka, M. *et al*., 1998).

Taking into account the positive effects of LAB fermentation on the legume properties and the drop in pH due to lactic acid formation, the aim of the present study was to explore an alternative extraction method of peanut proteins based on high power sonification and fermentation, where the decrease in pH was achieved by lactic fermentation instead of mineral acid addition. Two different commercial LAB strain or starters were selected for their aptitude for acidification and / or their recognized positive effect on legume protein properties: *Lactobacillus plantarum* and *Pediococcus acidilactici*. The fermentation-assisted extraction was expected to modify the protein profile isolated with this process. To evaluate this effect, extraction yield of protein isolates were evaluated by response surface methodology. Other biochemical, functional and physical properties of the samples were further analyzed to evaluate proteins which are extracted from defatted peanut flour.

5. Knowledge/Technology gaps and justification for taking up the present project including the questions to be answered :

Peanut is the oilseed which is high in fat content, good in protein content, high in energy content, average in carbohydrate content and good in fiber content. It also contains many other functional compounds like fibers, polyphenols, antioxidants, vitamins and minerals. (Kathleen, 2015). Peanuts contain all the 20 amino acids in variable proportions and is the biggest source of the protein called "arginine" (USDA, 2014). After the peanut oil is extracted, the protein content in the cake can reach 50% (Zhao et al., 2011).

Extraction of peanut protein from defatted peanut flour carried out by different conventional methods. But nutritional, sensory and technological properties of peanut proteins can be influenced due to these processes. A treatment combination i.e. High power sonication and Fermentation methods might be improve the above said properties of peanut protein. Water to defatted peanut flour might be affect the different strains of lactic acid producing bacteria and sonication process. So, the effect of different factors will be checked in this experiment.

The method and data for extraction of protein from different legumes through sonication and fermentation is available. But, very negligible information is available for extraction of peanut protein from defatted peanut flour. Hence, the experiment on for extraction of peanut protein from defatted peanut flour is adopted in this study to develop the process technology and to generate the information about the interaction between process parameters to optimize the levels which will be helpful to the society and food processors.

6. **Critical review of present status of the technology at national and international levels along with complete references :**

- Emkani M. et al (2021) studied pea protein extraction through lactic fermentation. In this study, pH was reduced by lactic fermentation instead of mineral acid addition. Different bacterial strains viz. *Streptococcus thermophilus*, *Lactobacillus acidophilus* and *Bifidobacterium lactis* are used for the protein extraction. Total nitrogen content and protein nitrogen content of globulin fraction was observed ~ 14.5 % and ~ 9.5 % respectively. While total nitrogen content and protein nitrogen content of albumin fraction was observed ~ 11 % and ~ 7 % respectively. Nitrogen extraction yield of globulin and albumin fractions was found ~ 48 % and ~ 35 % respectively. In this study, SDS-PAGE was also performed for polypeptide profiling. Globulin-rich sample profiles revealed the presence of bands ranging from 10 to 99 kDa, characteristic of pea proteins. Various subunits of vicilin including the monomer (Vαβγ, ~50 kDa, Vαβ, ~30–36 kDa, Vβγ, ~25–30 kDa, Vα, ~20kDa, Vβ, ~13kDa, Vγ, ~12–16 kDa), legumin monomer (Lαβ, ~60kDa) and the higher-molecular-weight bands corresponded to lipoxygenase (LOX ~94 kDa) and convicilin (CV, ~71 kDa) was observed while in albumin rich sample profiles also showed clear bands of LOX, lectine (Lect, ~17 kDa) and some contaminations by globulin polypeptides, mainly Vαβ.
- Gayol *et al*. (2013) reported the optimization of protein concentration process from residual peanut oil cake (POC). Different protein extraction and precipitation conditions were used: water/flour ratio (10:1, 20:1 and 30:1), pH (8.0, 9.0 and 10.0), NaCl concentration (0 and 0.5 M), extraction time (30, 60 and 120 mins.), temperature (25, 40 and 60^{o}C), extraction stages (1, 2 and 3), and precipitation pH (4.0, 4.5 and 5.0). The extraction and precipitation conditions which showed the highest protein yield were 10:1 water / flour ratio, extraction at pH 9.0, without NaCl, 2 staeges of 30 mins. At 40^{o}C and precipitation at pH 4.5. Under these conditions, the peanut protein concentrate (PC) obtained 86.22 % protein, while the initial POC had 38.04 %.
- Gao Z. et al. (2020) studied the impact of alkaline extraction pH (8.5, 9.0, and 9.5) on chemical composition, molecular structure, solubility and aromatic profile of pea protein isolate (PPI). They observed that protein recovery yield increased from 49.20% to 57.56% as the alkaline extraction pH increased from 8.5 to 9.5.pH 9.0 was found to be the optimal condition for preparing premium PPI in terms of yield, functionality, and aromatic profile using alkaline extraction-isoelectric precipitation process. PPI extracted at pH 9.0 possessed the lowest beany flavor The lowest lipoxygenase activity at pH 9.0 may contribute to the least beany flavor in PPI.
- Gore et al (2022) analysed proteins from different varieties of groundnut seeds through SDS-PAGE profiling. Protein fraction viz. albumin, globulin, glutelin and prolamin were extracted during the study, in which albumin % and globulin % content found to be in range of 16.2 to 20.43 % and 72.05-78.5 % respectively while glutelin % and prolamin % was found to be very lower in all varieties with the mean of 2.17 % and 2.57 % respectively. In SDS-PAGE profiling, it was observed albumin and globulin had the highest MW-Rf values in bands collectively (20–23), whereas glutelin and prolamin had the lowest MW-Rf values bands with ranged between 6-10 and correlation matrix between protein fractionation indicated that globulin was negatively correlated with prolamin and glutelin fraction.

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7. Expertise available with the investigating group/Institute

The PI & Co-PIs of project having enough experience of working in the field of Processing and Food Engineering. Experts in the field of Processing and Food Engineering. Assistant Biochemist is available from Dept. of Biochemistry & Biotechnology, JAU, Junagadh.

8. Brief note on Proprietary/Patent Perspective (for projects related to technology development)/Ethics/Animal Welfare/Bio Safety Issues

- No issues are there on these aspects.

9. (a) Expected output

- The process technology for the extraction of peanut protein using physical and biological methods will be standardized.
- The process technology can be made available to the commercial players and food processors.
- A green technology of protein extraction will be availed to the society.

(b) Clientele/Stake holders (including economic and socio aspects)

- Groundnut growers
- Groundnut processors
- Consumers

10. Signatures

[Project Leader] [Co-PIs] ……

11. Comments and signature

[Head of Division]

ANNEXURE- II

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

RESEARCH PROJECT PROFORMA FOR INITIATION OF A RESEARCH PROJECT (RPP - I)

(Refer for Guidelines ANNEXURE-XI (B))

1. Institute Project Code (to be provided by PME Cell)

2. Project Title : Optimization of process parameters for protein extraction from defatted peanut flour through fermentation.

3. Key Words : Defatted peanut flour, fermentation, peanut protein, Bacterial strains : *Lactobacillus plantarum* and *Pediococcus acidilactici*, High power sonication.

4. (a) Name of the Lead Institute : College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh

(b) Name of Division/ Regional Center/ Section : AICRP on PHET, Junagadh centre

5. (a) Name of the Collaborating Institute(s) : --

(b) Name of Division/ Regional Center/ Section of Collaborating Institute(s) : ---

6. Project Team (Name(s) and designation of PI, CC-PI and all project Co-PIs, with time proposed to be spent)

Sr. No.	Name, designation and institute	Status in the project (PI/CC-PI/ Co-PI)	Time to be spent (%)	Work components to be assigned to individual scientist
1.	Prof. A. M. Joshi Assistant Microbiologist, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	PI	60%	1. Review collection/literature survey 2. Collect the bacterial cultures from MTCC, Chandigarh and take a Preliminary trial. 3. Process development for peanut protein isolate using defatted peanut flour. 4. Laboratory trials as per the different treatments. 5. Physico-chemical and sensory analysis of the products. 6. Data collection and its analysis. 7. Report writing.
2.	Dr. P. J. Rathod Assistant Biochemist, Dept. of Bio-Technology, JAU, Junagadh	Co-PI-I	15%	To assist the PI to carry out biochemical analysis of the product

3.	Dr. P. R. Davara, Assistant Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	Co-PI-II	15%	1. To assist the PI to carry out the engineering parameters of the product. 2. To assist the PI in statistical analysis.
4.	Dr. M. N. Dabhi, Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh.	Co-PI-III	10%	To assist the PI in taking administrative approvals as and when needed to carry out the different project related activities.

7. Priority Area to which the project belongs : Post Harvest Technology

(If not already in the priority area, give justification)

8. Project Duration : Date of Start: 01-03-2024 Likely Date of Completion **:**31-12-2025

9. (a) Objectives :

- To study the effect of process parameters on recovery of peanut protein isolate from defatted peanut flour through fermentation method.
- To determine biochemical and physical properties of peanut protein isolate.
- To determine the functional properties of the peanut protein isolate.

(b) Practical utility :

- The process technology for the extraction of peanut protein using physical and biological methods will be standardized.
- The process technology can be made available to the commercial players and food processors.
- A green technology of protein extraction will be availed to the society.

10. Activities and outputs details :.

Objective wise	Activity	Month & Year of		Output monitorable target(s)	% to be carried out in different years			Scientist(s) responsible
		Start	Comple-tion		1	2	..	
1.	Review collection	March-24	May-24	1. To collect the data on extraction of protein from defatted peanut flour. 2. To study the work done in the past.	100%	--	-	Prof. A. M. Joshi
2.	Procurement and Quality analysis of proposed product raw material	June-24	Aug-24	Procurement of defatted peanut flour and bacterial cultures. Quality will be analysed.	100%	--	- -	Prof. A. M. Joshi Dr. M. N. Dabhi
3.	Preliminary laboratory trials	Sept-24	Jan-25	Preliminary trial run for peanut protein extraction will be carried out.	100%	--	- - -	Prof. A. M. Joshi, Dr. P. R. Davara Dr. P. J. Rathod
4.	Extraction of peanut protein as per the final treatments.	Feb-25	May-25	Final treatment trials and quality analysis will be carried out.	--	100%	- - -	Prof. A. M. Joshi, Dr. P. R. Davara Dr. P. J. Rathod
5.	Quality analysis of peanut protein isolates.	June-25	Sept-25	Peanut protein will be analysed for its physical, biochemical and functional quality.	--	100%	- - -	Dr. P. J. Rathod Prof. A. M. Joshi, Dr. P. R. Davara,
6.	Data analysis and report writing	Oct-25	Jan-26	Compilation of collected data and preparation of report	--	100%	- - -	Prof. A. M. Joshi, Dr. P. R. Davara, Dr. M. N. Dabhi

Work Plan/Activity Chart

	2024									2025												2026
Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Review collection																						
			Procurement and Quality analysis of proposed product raw material																			
						Preliminary laboratory trials																
											Extraction of peanut protein as per the final treatments.											
															Quality analysis of peanut protein isolates.							
																			Data analysis and report writing			

11. Technical Programme (brief)

Justification :

Peanut is the oilseed which is high in fat content, good in protein content, high in energy content, average in carbohydrate content and good in fiber content. It also contains many other functional compounds like fibers, polyphenols, antioxidants, vitamins and minerals. (Kathleen, 2015). Peanuts contain all the 20 amino acids in variable proportions and is the biggest source of the protein called “arginine” (USDA, 2014). After the peanut oil is extracted, the protein content in the cake can reach 50% (Zhao et al., 2011).

Extraction of peanut protein from defatted peanut flour carried out by different conventional methods. But nutritional, sensory and technological properties of peanut proteins can be influenced due to these processes. A treatment combination i.e. High power sonication and Fermentation methods might be improve the above said properties of peanut protein. Water to defatted peanut flour might be affect the different strains of lactic acid producing bacteria and sonication process. So, the effect of different factors will be checked in this experiment.

The method and data for extraction of protein from different legumes through sonication and fermentation is available. But, very negligible information is available for extraction of peanut protein from defatted peanut flour. Hence, the experiment on for extraction of peanut protein from defatted peanut flour is adopted in this study to develop the process technology and to generate the information about the interaction between process parameters to optimize the levels which will be helpful to the society and food processors.

<u>Status (review)</u> :

- Emkani M. et al (2021) studied pea protein extraction through lactic fermentation. In this study, pH was reduced by lactic fermentation instead of mineral acid addition. Different bacterial strains viz. *Streptococcus thermophilus*, *Lactobacillus acidophilus* and *Bifidobacterium lactis* are used for the protein extraction. Total nitrogen content and protein nitrogen content of globulin fraction was observed ~ 14.5 % and ~ 9.5 % respectively. While total nitrogen content and protein nitrogen content of albumin fraction was observed ~ 11 % and ~ 7 % respectively. Nitrogen extraction yield of globulin and albumin fractions was found ~ 48 % and ~ 35 % respectively. In this study, SDS-PAGE was also performed for polypeptide profiling. Globulin-rich sample profiles revealed the presence of bands ranging from 10 to 99 kDa, characteristic of pea proteins. Various subunits of vicilin including the monomer (Vαβγ, ~50 kDa, Vαβ, ~30–36 kDa, Vβγ, ~25–30 kDa, Vα, ~20kDa, Vβ, ~13kDa, Vγ, ~12–16 kDa), legumin monomer (Lαβ, ~60kDa) and the higher-molecular-weight bands corresponded to lipoxygenase (LOX ~94 kDa) and convicilin (CV, ~71 kDa) was observed while in albumin rich sample profiles also showed clear bands of LOX, lectine (Lect, ~17 kDa) and some contaminations by globulin polypeptides, mainly Vαβ.
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% respectively. In SDS-PAGE profiling, it was observed albumin and globulin had the highest MW-Rf values in bands collectively (20–23), whereas glutelin and prolamin had the lowest MW-Rf values bands with ranged between 6-10 and correlation matrix between protein fractionation indicated that globulin was negatively correlated with prolamin and glutelin fraction.

Objectives :

1. To study the effect of process parameters on recovery of peanut protein isolate from defatted peanut flour through fermentation method.
2. To determine biochemical and physical properties of peanut protein isolate.
3. To determine the functional properties of the peanut protein isolate.

Technical programme

- **Experimental Detail :**
  - (a) Experimental Design : Response Surface Methodology : CCRD (3 = 2 numerical factors + 1 categoric factor)
  - (b) Base material : Defatted peanut flour
  - (c) Bacterial cultures : *Lactobacillus plantarum* (L) & *Pediococcus acidilactici* (P)

  (Two different experiments are to be conducted for two bacterial cultures as per the below given treatments)

- **Treatments Detail :**

Independent parameters

Sr. No.	Factor	Code	Coded levels				
			-2	-1	0	+1	+2
1	Water to flour ratio	X_1	6 : 1	7.5 : 1	9 : 1	10.5 : 1	12 : 1
2	Sonication time	X_2	2	4.5	7	9.5	12

- **Treatment combinations :**

Run	Water to Flour Ratio	Sonication time (minutes)
1	9 : 1	2.0
2	10.5 : 1	9.50
3	7.5 : 1	9.50
4	12 : 1	7.00
5	9 : 1	12.00
6	6 : 1	7.00
7	9 : 1	7.00
8	9 : 1	7.00
9	9 : 1	7.00
10	7.5 : 1	4.50
11	9 : 1	7.00
12	9 : 1	7.00
13	9 : 1	7.00
14	10.5 : 1	4.50

- **Dependent parameters :**
    1. Acidification kinetics at 0,6,12,24,48 and 72 hours
    2. Biochemical parameters
        a) Moisture content
        b) Oil content
        c) Ash content
        d) SDS-PAGE
    3. Physical parameters
        a) Bulk density
        b) Tapped density
    4. Functional parameters
        a) Protein yield
        b) Water absorption index
        c) Water solubility index

Methodology :

Defatted Peanut Flour

↓

Water to Flour Ratio
(6:1 to 12:1 - as per RSM design, pH of water : 6.5)

↓

Sonication at 100 % amplitude
(2 mins. to 12 mins. – as per RSM design)

↓

Inoculate the bacterial strains @ 10^8 cfu / ml
(*Lactobacillus plantarum* (L) and *Pediococcus acidilactici* (P)

↓

Sample mixing at 200 rpm, 37°C and fermentation process upto 96 hours

↓ Sampling and pH measurement at 0, 24, 48, 72, 96 hours

Carried out the acidification upto pH 4.2 - 4.8

↓

Centrifugation (10,000 rpm, 10 minutes)

↓

Collection of solid phase pellets

↓

Drying, storage and analysis of different parameters

Fig. 9.1 : Process flow chart for extraction of peanut protein.

Possible outputs :

- The process technology for the extraction of peanut protein using physical and biological methods will be standardized.
- The process technology can be made available to the commercial players and food processors.
- A green technology of protein extraction will be availed to the society.

References :

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12. Financial Implications (in Lakhs) : Rs. 39.32 lakhs

(A) Financed by the institute

12.1 Manpower (Salaries / Wages)

S. No.	Staff Category	Man months	Cost
1.	Scientific	23	35,00,000
2.	Technical	5	4,00,000
3.	Supporting	--	--
4.	SRFs/RAs	--	--
5.	Contractual	--	--
	Total	28	39,00,000

12.2 Research/Recurring Contingency

S. No.	Item	Year(1)	Year (2)	Year (3)…	Total
1.	Consumables	10000	10000	--	20000
2.	Travel	5000	--	--	5000
3.	Field Preparation/ Planting/ Harvesting (Man-days/costs)	--	--	--	--
4.	Inter-cultivation & Dressing (Man-days/costs)	--	--	--	--
5.	Animal/Green house/Computer Systems/Machinery Maintenance	2000	--	--	2000
6.	Miscellaneous(Other costs)	5000	--	--	5000
	Total(Recurring)	22000	10000	--	32000

Justification : ---

12.3 Non-recurring (Equipment)

S. No.	Item	Year (1)	Year (2)	Year (3)…	Total
1.	--	--	--	--	--
2.	--	--	--	--	--
	Total (Non-recurring)	--	--	--	--

Justification : ---

12.4 Any Other Special Facility required (including cost)

12.5 Grand Total (12.1 to 12.4)

Item	Year (1)	Year (2)	Year (3)	Total
Grand Total	20,00,000	19,32,000	--	39,32,000

(B) Financed by an organization other than the Institute (if applicable) : No

- Name of Financing Organization : NA
- Total Budget of the Project :
- Budget details

S. No.	Item	Year(1)	Year(2)	Year (3)…	Total
1	Recurring Contingency				
	Travelling Allowance	--	--	--	--
	Workshops	--	--	--	--
	Contractual Services/ Salaries	--	--	--	--
	Operational Cost	--	--	--	--
	Consumables	--	--	--	--
2	Non - Recurring Contingency				
	Equipment	--	--	--	--
	Furniture	--	--	--	--
	Vehicle	--	--	--	--
	Others (Miscellaneous)	--	--	--	--
3	HRD Component				
	Training	--	--	--	--
	Consultancy	--	--	--	--
4	Works (i) New (ii) Renovation	--	--	--	--
5	Institutional Charges				

ANNEXURE - III
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
CHECKLIST FOR SUBMISSION OF RPP-I
(Refer for Guidelines ANNEXURE-XI(C)

1. Project Title : Optimization of process parameters for protein extraction from defatted peanut flour through fermentation.
2. Date of Start & Duration : March – 2024 to December - 2025
3. Institute Project [√] or Externally Funded [ ]
4. Estimated Cost of the Project : 39,32,000/- INR
5. Project Presented in the Divisional/Institutional Seminar? Yes / ~~No~~ [√]
6. Have suggested modifications incorporated? ~~Yes~~ / No [ ]
7. Status Report enclosed ~~Yes~~ / No
8. Details of work load of investigators in approved ongoing projects:

Project Leader				Co-PI – I				Co-PI – II…			
Proj. Code.	% Time spent	Date of start	Date of completion	Proj. Code.	% Time spent	Date of start	Date of completion	Proj. Code.	% Time spent	Date of start	Date of completion

9. Work Plan/Activity Chart enclosed Yes / ~~No~~ [√]
10. Included in Institute Plan Activity Yes / ~~No~~ [√]
11. Any previous Institute/Adhoc/Foreign aided projects on similar lines? ~~Yes~~ / No [√]
12. New equipment required for the project ~~Yes~~ / No [√]
13. Funds available for new equipment ~~Yes~~ / No [√]
14. Signatures

Project Leader Co-PI-I Co-PI-II Co-PI–III

HOD/PD/I/c

ANNEXURE - IV

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

APPRAISAL BY THE PME CELL OF RPP-I

(Refer for Guidelines ANNEXURE-XI (D))

1. Institute Name : AICRP on PHET, JAU, Junagadh.

2. Project Title : Optimization of process parameters for protein extraction from defatted peanut flour through fermentation.

3. On scale 1-10 give score to (a) to (j)

(a)	Relevance of research questions	☐
(b)	Addressing priority of the institute and/or National priority	☐
(c)	New innovativeness expected in the study	☐
(d)	Appropriateness of design/techniques for the questions to be answered	☐
(e)	Elements of bias addressed in the study	☐
(f)	Adequacy of scientist(s) time allocation	☐
(g)	Extent of system review and meta-analysis	☐
(h)	Effective control to experiments	☐
(i)	Economic evaluation and cost efficiency analysis	☐
(j)	How appropriately the expected output answers the questions being addressed in the specific subject matter/area (Basic/Applied/Translational/Others)?	☐
	***Total Score out of 100**	

* The score obtained is suggestive of the overall quality ranking of the project

4. Was there any other project carried in the past in the same area/topic?

Yes ☐ No ☐

If yes, list the project numbers.

5. Signature of PME Cell Incharge

SUMMARY OF PROGRESS REPORT

1. PH/JU/85/1 : Operational research project on Agro Processing Centres.

At Tadka Pipaliya agro processing center, oil milling, wheat cleaning, groundnut decortication, sesame processing, groundnut threshing, pulse milling and spice milling operations were carried out. They have earned about Rs. 92,500/-.

At Agro Processing Center, Virol, oil milling, spice milling and wheat cleaning were carried. They have earned about Rs. 67,850/-

At Agro Processing Centre, Loej, oil milling and wheat cleaning were carried out. They have earned about Rs. 2,02,000/-

2. PH/JU/2018/02 : Standardization of process technology for preparation of peanut sauce and peanut wadi (Chunks).

A. Peanut sauce production

Defatted peanut cake, contains about 43 to 65% protein. Protein is one of the important compounds in the balanced diet. With globalization, the sauce has now reached the international realm where the condiment can be found in commercial and home kitchens in both the East and the West. Defatted peanut kernel and defatted peanut cake were selected as basic raw material for the production of peanut sauce through chemical and fermentation process, respectively. Wheat was used as another raw material in both the methods. Soaked defatted peanut kernels and roasted wheat pieces were used in the production of peanut sauce.

1. Chemical hydrolysis method

The effect of three independent process variables *viz.*, defatted peanut kernel (10, 26, 50, 74 and 90%), acid concentration (15, 17, 20, 23 and 25%) and hydrolysis time (15, 17, 20, 23 and 25 h) were optimized using response surface methodology. The optimum treatment conditions were found to be 90% defatted peanut kernel, 16.5% acid concentration and 25 h hydrolysis time for the production of peanut sauce through acid hydrolysis method.

2. Fermentation process

Three different microbial cultures, *viz. Aspergillus oryzae* (*koji* mold), *Pediococcus halophilus* (lactic acid bacteria) and *Saccharomyces rouxii* (osmophilic yeast were purposively used in the preparation of fermented peanut sauce. The effect of two independent parameters *viz.*, defatted peanut cake (10, 21.72, 50, 78.28, and 90%) and brine fermentation time (30, 52, 105, 158 and 180 days) were optimized using response surface methodology. The optimum treatment conditions were found to be, 66% defatted peanut cake and 158 days of brine fermentation time for the production of peanut sauce through fermentation process.

B. Peanut wadi production

- Number of trials were conducted for the preparation of peanut wadi using the Twin Screw Extruder (Made : BTPL, Kolkata).
- Due to high moisture of defatted peanut flour it was converted into dough and lost its ability to free flow in the machine. As a consequence, there was an issue with feeding of raw material in the extruder machine.

- Further, the facility to add the moisture in the raw material after the material is fed in the machine is not working properly. Hence, the feeding of raw material and addition of moisture simultaneously is not possible in the machine.
- In some trials, the required texture in the peanut wadi could not be developed.
- In conclusion, the Twin Screw Extruder available in the department is not suitable to develop the texturized peanut wadi.
- As per the suggestion during 38th AICRP workshop, we have approached CIPHET to develop the peanut wadi using the Soy Wadi machine developed by CIPHET. But, the said machine is not working on an extrusion technology. Hence this machine is not capable to texturize the peanut protein and found to be not suitable for the manufacturing of Peanut wadi with textured protein.
- One manufacturer of soy *wadi* at Surat, Gujarat contacted for the production of peanut wadi. But, the minimum raw material required per batch/trial is about 50 kg as per the capacity of the machine and large quantity of peanut flour may be required for conducting the whole experiment. Hence, conducting the different treatments/research trials using commercial machine practically not feasible.
- Looking to above difficulties, the research work on peanut wadi could not be completed.

3. PH/JU/2023/1 : Management of insect pest of storage wheat in bin by ozone.

As per the proceeding of the last year, 20 GI metal cylindrical storage bins from the Rajkot centre purchased. That was received by September 2023. In market, there was not available the bin as per our desire. We have contacted to different bin manufacturers. We convinced them to fabricate for 100 kg capacity bin. Accordingly, we have advertised in Newspaper and received hard copy of tenders. But due to new purchase policy we have to purchase it under GeM process. Accordingly, we have purchase 20 GI metal cylindrical storage bins.

Action Taken of proceeding of 38th Annual Workshop.

Sr. No.	Project	Comment	Action Taken
1.	Optimization of process parameters for protein extraction from peanut through fermentation.	Project was not approved due to Commercial patent search should be done before proposing the project in the future.	- There is no any patent available of extraction of peanut protein through fermentation. - Only patents were granted for the extraction of peanut protein through the chemical methods. - Search report is submitted on 10/03/2023 with request to approve the project proposal.
2.	Management of insect pest of storage wheat in bin by ozone.	Ozone diffusion model in 100 kg capacity should be developed. • The developed model must be validated in storage of 1 ton wheat. • Efforts should be made to prevent leakage of ozone from large capacity bins. • Approved and revised proposal	• As there was no instrument available, ozone reaction rate is not determined and model is not developed for 100 kg capacity. • 100 kg capacity bin is fabricated and trial will be started with this season. • Ozone leackage will be

		should be submitted to PC Unit within 3 months.	checked during the trial. • Revised proposal is submitted to PC unit on Dated 10/07/2023.
3.	Processing of green tender sorghum.	Progress was not satisfactory. • Submit status report & close the project.	Suggesstions implemented and project was closed.
4.	Standardization of process technology for preparation of peanut sauce and peanut wadi (Chunks).	Scale up the technology • Detailed rheologial properties and flow behaviour should be studied. • Extension of one year for scale up of solid state fermentation to pilot plant level was granted. • Review the wadi making process and publish a review paper. • Wadi making process developed by ICAR-CIPHET should also be evaluated.	1. Fermentation plant manufacturer was contacted for scale up the technology. Details is provided in the RPP-IV. 2. Viscosity of peanut sauce was measured and reported in the RPP-III. 3. Estimated cost was obtained from the respective manufacturer of pilot scale plant for peanut sauce production. However, the plant will be established upon availability of required grant.

			4. Publication of review paper is under progress. 5. Dr Sandeep Man, Principal Scientist, CIPHET was approached to develop the peanut wadi using the Soy Wadi machine developed by CIPHET. But, the said machine is molding machine and not an extrusion technology. Hence this machine is not capable to texturize the peanut protein and found to be not suitable for the manufacturing of Peanut wadi with textured protein in the final product. Hence the trials are not conducted with this machine.

Tentative Technical Programme for the year 2024-2025

Sr. No.	Code No.	Title
1.	PH/JU/85/1	Establishment of Agro Processing Centre training and demonstration of technologies (Operational research project on Agro Processing Centres)
2.	PH/JU/2020/01	Standardization of process technology for preparation of peanut sauce and peanut wadi (Chunks).
3.	PH/JU/2023/01	Management of insect pest of storage wheat in bin by ozone.
4.	New Investigation - I	Valorization of onion waste product for reinforcement of starch based biodegradable plastic.
5.	New Investigation - II	Valorization of pulse processing industrial waste for RTE product.
6.	New Investigation - III	Development of protein enriched Ready-to-Eat extruded product ideal for fasting by supplementing defatted peanut flour.
7.	New Investigation – IV	Development of millet based extruded product supplemented with defatted peanut flour.
8.	New Investigation – V	Optimization of process parameters for protein extraction from defatted peanut flour through fermentation.

PUBLICATION, TRAINING AND DEMONSTRATION

Publications :

Books/Book Chapter/Bulletin:

1. P. R. Davara, V. P. Sangani. Clarification of Prickly Pear Juice Using Honey. Scholar's press, Omni Scriptum Publishing Group, Mauritius. 2023.
2. Dr. M. N. Dabhi. Enzymatic process for pigeon pea. J. C. Jimenez-Lopez, & A. 2023.
3. Dr. P. R. Davara, Prof. V. P. Sangani, Dr. M. N. Dabhi. "ફળ અને શાકભાજીનું કેનિંગ દ્વારા પરિરક્ષણ". Director of Extension Education, Anand Agril. University, Anand. 2023.
4. Dr. P. R. Davara, Prof. V. P. Sangani, Dr. M. N. Dabhi. "ચીકુમાં પરિરક્ષણ" Director of Extension Education, Anand Agril. University, Anand. 2023.
5. Dr. P. R. Davara, Dr. A. K. Varshney, Mr. Naliyapara Viraj. "થોરના જિંડવાનું પ્રોસેસીંગ દ્વારા પરિરક્ષણ". Director of Extension Education, Anand Agril. University, Anand. 2023.
6. Dr. P. R. Davara, Dr. R. L. Rajput. "મશરૂમમાં પરિરક્ષણ". Director of Extension Education, Anand Agril. University, Anand. 2023.
7. Dr. P. R. Davara, Prof. V. P. Sangani, Dr. R. L. Rajput. "ડબ્બા બંધી કરેલ ફળ અને શાકભાજીમાં થતો બગાડ અને તેનું નિવારણ". Director of Extension Education, Anand Agril. University, Anand. 2023.
8. Mr. A. V. Kotecha, Dr. P. R. Davara, Mr. A. H. Bhatt. "લીંબુમાં પરિરક્ષણ". Director of Extension Education, Anand Agril. University, Anand. 2023.
9. Dr. R. L. Rajput, Dr. P. R. Davara, Prof. V. P. Sangani. "ફળ અને શાકભાજીમાં પેકેજીંગની અગત્યતા". Director of Extension Education, Anand Agril. University, Anand. 2023.
10. V. P. Sangani, P. R. Davara, G. D. Gohil. Garlic: A Flavorful and Functional Food with Impressive Health Benefits. Agriculture & Food : e-Newsletter, Vol. 5, Issue 6, June-2023.
11. P. R. Davara, V. P. Sangani, G. D. Gohil. Nonconventional Drying Techniques for Improving Product Quality and Energy Efficiency. Agriculture & Food : e-Newsletter, Vol. 5, Issue 6, June-2023.
12. P. R. Davara. "કૃષિ પેદાશોના પ્રાથમિક પ્રોસેસિંગ માટેની અત્યાધુનિક પધ્ધતિઓ". In the manual of training on "*ચોક્સાઈ પૂર્વકની આધુનિક ખેતીમાં કૃષિ ઈજનેરીના વિવિધ આયામો*" held at Res. Scientist (Agril. Engg.), JAU, Junagadh on 9th June, 2023.
13. P. R. Davara, V. P. Sangani, G. D. Gohil. Exploring Dielectric and Microwave Heating for Enhanced Food Processing. Agriculture & Food : e-Newsletter, Vol. 5, Issue 7, July-2023.
14. V. P. Sangani, P. R. Davara, G. D. Gohil. Food Preservatives: Classification, Types, and Importance. Agriculture & Food: e-Newsletter, Vol. 5, Issue 8, Aug-2023.
15. G. D. Gohil, V. P. Sangani, P. R. Davara. Image Processing Techniques for Sorting and Grading of Fruits and Vegetables. Agriculture & Food: e-Newsletter, Vol. 5, Issue 8, Aug-2023.
16. V. P. Sangani, P. R. Davara, G. D. Gohil. Application of Ultrasound Technology in Food Processing. Agriculture & Food: e-Newsletter, Vol. 5, Issue 9, Sept-2023.
17. P. R. Davara, V. P. Sangani, G. D. Gohil. Non-Thermal Processing Techniques for Food Preservation. Agriculture & Food: e-Newsletter, Vol. 5, Issue 9, Sept-2023.

18. V. P. Sangani, P. R. Davara, G. D. Gohil. Pearl Millet as a Functional Food. Agriculture & Food: e-Newsletter, Vol. 5, Issue 11, Nov-2023

Research Articles:

1. Shingala AM and M N Dabhi. 2023. Influence of Ozone Treatment on Wheat (Triticum aestivum) Germination during Bulk Storage. Journal of Cereal Research.14(3): 283-290. No NAAS. 2023.
2. Devanand Gojiya, Ankitkumar Barad, Vanraj Gohil, Mukesh Dabhi, Navnitkumar Dhamsaniya, Viraj Naliapara, Parthkumar Sapariya. 2023. Quantification of design associated engineering properties of seed varieties as a function of moisture content. Journal of the American Oil Chemists' Society. https://doi.org/10.1002/aocs.12691. No NAAS. 2023.
3. Paresh Davara, Ashish Joshi, Mukesh Dabhi, Pankajkumar Radhod, Parthkumar Sapariya. 2023. Physical and sensory properties of peanut sauce prepared through fermentation process. The Pharma Innovation. 12(5):2620-2625. NAAS 5.23. 2023.
4. Devanand Gojiya, Vanraj Gohil, Mukesh Dabhi, Navnitkumar Dhamsaniya. 2023. Assessment of water absorption characteristics for improved sesame (Sesamum indicum L.) varieties during hydration. Food Bioengineering, 2(2):175– 183. https://doi.org/10.1002/fbe2.12051. No NAAS. 2023.
5. Kuldeep Naghera and Mukesh Dabhi. 2023. Standardization of flour proportion for pearl millet and chick pea based extruded product- A sensory approach. The Pharma Innovation. 12(8):489-493. NAAS 5.23 2023.
6. P. S. Sapariya, N. U. Joshi and M. N. Dabhi. 2023. Physical and functional properties of low temperature ground turmeric (Curcuma longa) powder. Journal of Spices and Aromatic Crops. 32(1):24-33. NAAS 5.11 2023. DOI:10.25081/josac.2023.v32.i1.7567.
7. N. U. Joshi, M. N. Dabhi and P. J. Rathod. 2023. A review on factors affecting dehusking operation of different agricultural products. The Pharma Innovation. 12(11):478-482. NAAS 5.23 2023.
8. Mansukh Somani, J.B. Bhimani, F.G. Sayyad, Nirav Pampaniya, AM Joshi, Vishal Kukadiya, Piyush Moradiya. 2023. Performance evaluation of on-farm natural ventilated evaporative cooling system for sapota storage. International Research Journal of Modernization in Engineering Technology and Science. 5(8).

Abstract Published:

-Nil-

Paper accepted, presented & published in Conference Proceeding

1. V. P. Sangani , H. R. Sabhadiya and P. R. Davara. International Development of Muffins Incorporated with Plant based Functional Ingredients. International conference on millets for achieving nutritional and security achivments, 21-23, September, 2023.
2. M. N. Dabhi. State level seminar on "Modern Agricultural Practices of Coconut: Problems and Remedies" organized by Junagadh Agricultural University, Junagadh and The Gujarat

Association for Agricultural Scienses, Zonal Chapter, Junagadh. National Value addition in Coconut. June 2023

3. M. N. Dabhi. Sensory evaluation of extruded products for standardization of proportion of pearlmillet and chickpea "International conference on Millets for achieving nutritional and economic security" to held at NIFTEM, Kundli, Haryana during International Conference September 21-23, 2023
4. M. N. Dabhi. Optimization of chemical pretreatment on different parameters of osmotic dehydrated onion slices using response surface method. National symposium cum Industry Meet on "Agri-Business in Alliums: Innovation, Promotion & Sustainability" 20-22, December, 2023.
5. M. N. Dabhi. Artificial curing of onion. National symposium cum Industry Meet on "Agri-Business in Alliums: Innovation, Promotion & Sustainability". 20-22, December, 2023.
6. M. N. Dabhi. Turmeric grinding in a jacketed grinding mill. 57th Annual COnvention of ISAE on Agri-Food System's Transformation through Engineering Innovations National 6-8 November, 2023.

Extension Activities :

1. M. N. Dabhi has attended Shatrabhuj FPO meeting and guided at Tadka Pipaliya on 05/02/2023.
2. M. N. Dabhi has attended meeting of the committee regarding "AFUFITL 5FSMDF\ SF56L 5KL AUF0 V8SFJJF B[TZ 5Z DF/BFSLI ;]lJWF pEL SZJF" on 21/03/2023, 11/04/2023 conveyed by the Director of Horticulure, Gujarat State, Gandhinagar.
3. P. R. Davara delivered the lecture on "Agro food processing and value addition in fruit crops" during farmers training organized by FTC, Junagadh at Centre of Excellence for Mango, Talala on 03-01-2023.
4. P. R. Davara delivered the lecture on "કૃષિ પેદાશોના પ્રાથમિક પ્રોસેસીંગ માટેની અત્યાધુનિક પદ્ધતિઓ" during farmers training organized by Research Scientist (Agril Engg), RTTC, JAU on 09-06-2023.
5. P. R. Davara delivered the lecture on "New modern technology of primary food processing of agricultural produce" during farmers training organized by FTC, Junagadh at Jamwala (Gir gadhada) on 26-10-2023.
6. P. R. Davara delivered the lecture on "ખેતી પેદાશોનું માર્કેટિંગ અને વેલ્યુ અડીશન" during progressive farmers training organized by SSK, JAU on 12-12-2023.
7. P. R. Davara delivered the lecture on "New modern technology of primary food processing of agricultural produce" during farmers training organized by FTC, Junagadh at Pirvad (Visavadar) on 22-12-2023.
8. P. R. Davara delivered the lecture on "Latest trends in food processing industry and processing of horticultural (mango) produce" during farmers training organized by FTC, Junagadh at Thordi (Gir Gadhada) on 10-01-2024.

Demonstration conducted

Krishimela

Training and Demonstration Mela was organized by and at Junagadh Agricultural University, Junagadh on 4th February, 2023. About 150 farmers have participated in the demonstration.

Inauguration of Demonstration Mela

Address by Dr. V. P. Chovatiya,
Hon. Vice Chancellor, JAU, Junagadh.

Address by Dr. H. M. Gajipara,
Director of Research, JAU, Junagadh.

Farmers Participation in Krishimela

Demonstration of Machineries at AICRP on PHET, Junagadh center stall

Plate Ex. Act. 1 : Photographs of Training and Demonstration Mela.

Krishi Mahotsav

Krishi mahotsav – 2023 was organized by Govt. of Gujarat. Scientists of Agricultural universities of gujarat ordered to give information regarding new technologies in Agriculture, value addition and importance of millets in a diet.

Plate Ex. Act. 2 : Prof. A. M. Joshi perform a duty as a Taluka nodal scientist in Krishi Mahotsav – 2023 in Bhinda village, Tal. Jam-Khambhaliya, Dist. Devbhoomi Dwarka.

Plate Ex. Act. 3 : Dr. P.R. Davara perform a duty as a Taluka nodal scientist in Krishi Mahotsav – 2023 in Sutrapada, Tal. Sutrapada, Dist. Gir Somnath.

HUMAN RESOURCE DEVELOPMENT

1. P.R. Davara participated in one day Webinar on "Future of Indian Agriculture: Challenges and Opportunities" organized by DSW, MPUAT, Udaipur during 22-05-2023.
2. M. N. Dabhi, P. R. Davara and A. M. Joshi participated in 38th Annual workhop of AICRP on PHET, Kasargod, Kerala, during February 20-22, 2023. AICRP on PHET, Project Co-ordinator office, Ludhiana.
3. M. N. Dabhi participated in International consference on Millets for Achieving Nutritional and Economic Security (ICMANES-2023) organized by National Institute of Food Technology Entrepreneurship and Management, Kundli Sonepat during 21-23 September, 2023.
4. M. N. Dabhi, P. R. Davara and A. M. Joshi participated in Workshop on "The Growing Role of Artificial Intelligence in Agriculture: Revolutionizing Farming Practices" organized by JAU, Junagadh during 4-5 December, 2023.
5. M. N. Dabhi, P. R. Davara and A. M. Joshi participated in Workshop on "Use of Modern Technologies and Automation in Food Processing" Junagadh Agricultural University, Junagadh during January 05-06, 2023 Department of Processing and Food Engineering, CAET, Junagadh.

6. P.R. Davara participated in two days Workshop on “Waste Utilization and Management for Energy Generation” organized by Dept. of R.E.E., C.A.E.T., J.A.U., Junagadh during 16-02-2023 to 17-02-2023.
7. P.R. Davara participated in two days Workshop on “Application of Robotics and Drone Technologies in Agriculture” organized by Dept. of F.M.P.E., C.A.E.T., J.A.U., Junagadh during 02-03-2023 to 03-03-2023.
8. Dr. P.R. Davara took an international training on Prepared Consumer Foods Processing and Packaging at Food Industry Development Department, Teagasc, Food Research Centre, Ashtown, Dublin, Ireland during 08-08-2023 to 14-09-2023 sponsored by Teagasc Food Research Centre, Ashtown, Dublin, Ireland.

Plate HRD -1 : Teagasc Ashtwon Food Research center, Dublin, Ireland

Plate HRD – 2 : Preparation of high moisture meat analogue from protein isolates

Plate HRD – 3 : Extraction of chitosan using Ultrasound technology

Plate HRD-4 : Packaging of fresh mushrooms using Thermosealer

Radio talks / TV talks delivered by scientists

1. Dr. P. R. Davara delivered the Radio talk "સીતાફળનું પ્રોસેસીંગ અને મૂલ્યવર્ધન" at AgrisNet studio, Junagadh Janwani, JAU, Junagadh 91.2 MHz on 10-01-2023.
2. Dr. P. R. Davara delivered the Radio talk "થોરના જીન્ડવાનું પ્રોસેસીંગ દ્વારા" at AgrisNet studio, Junagadh Janwani, JAU, Junagadh 91.2 MHz on 07-03-2023
3. Dr. P. R. Davara delivered the Radio talk "મસાલા દળવાની અત્યાધુનિક પધ્ધતિ" at AgrisNet studio, Junagadh Janwani, JAU, Junagadh 91.2 MHz on 10-05-2023
4. Dr. P. R. Davara delivered the Radio talk "બાગાયતી પાકોમાં મૂલ્યવર્ધનની આવશ્યકતા" at AgrisNet studio, Junagadh Janwani, JAU, Junagadh 91.2 MHz on 10-05-2023
5. Dr. M. N. Dabhi delivered the radio talk on "Importance of onion curing" in Junagadh Janwani 91.2 MHz on 10-05-2023.


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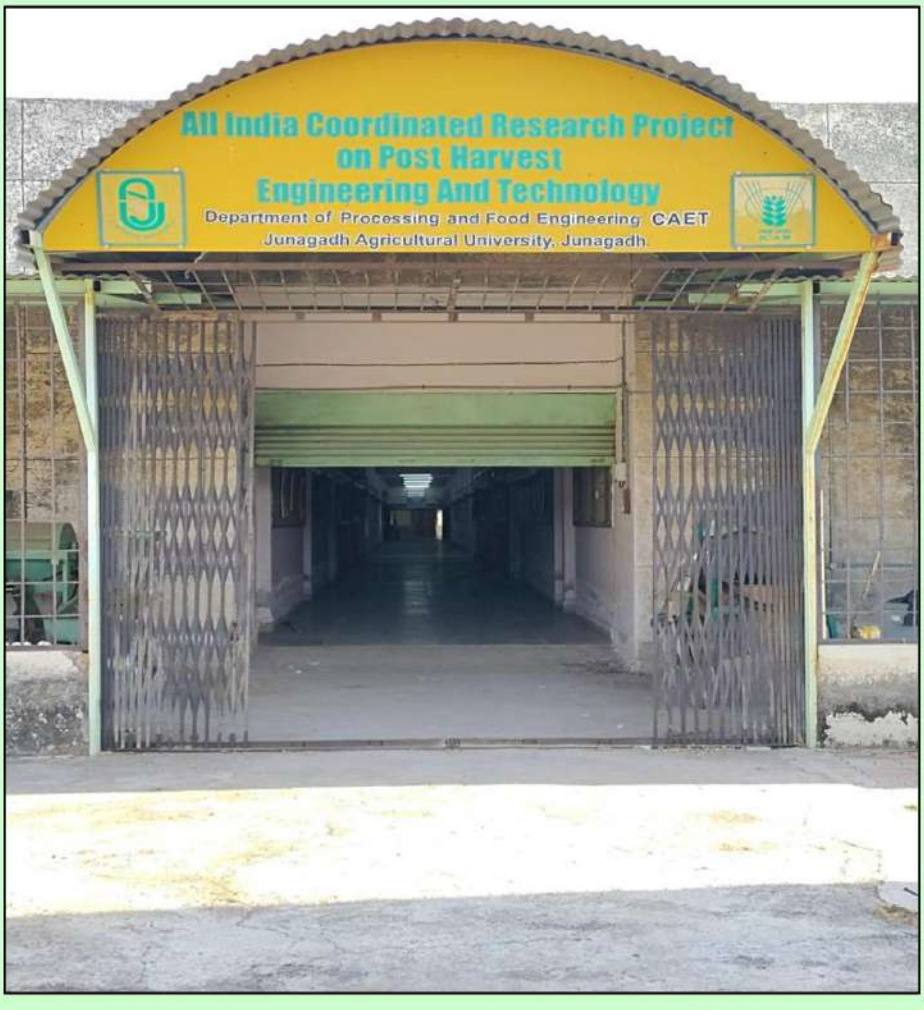
All India Coordinated Research Project
on Post Harvest
Engineering And Technology
Department of Processing and Food Engineering CAET
Junagadh Agricultural University, Junagadh.