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ANNUAL REPORT 2013-2014

All India Coordinated Research Project
on
Post Harvest Technology (ICAR)

भाकृअनुप
ICAR

KERALA AGRICULTURAL UNIVERSITY

Department of Food & Agricultural Process Engineering
Kelappaji College of Agricultural Engineering and Technology
Kerala Agricultural University
Tavanur, Kerala - 679 573

Research report No.KAU/PHT/2014/01
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All India Coordinated Research Project on Post Harvest Technology, Tavanur Centre

General Information

1.	Title of the Scheme	All India Coordinated Research Project on Post-Harvest Technology
2.	ICAR Sanction No. and Date	a) Council's No. 4-5/2003-1A-11(AE) dated 21/04/2004 b) 2(24) 2004/PHTS/ Thrissur dated 03/06/04 of Director & Project Coordinator, AICRP on PHT, CIPHET, Ludhiana.
3.	Date of Commencement	1st April 2004
4.	Date of Completion	Continuing 12th five year plan
5.	Sanctioned grant (ICAR) for the year for which this report is prepared	2013-14 & 2014-15 Rs.64,45,000/-

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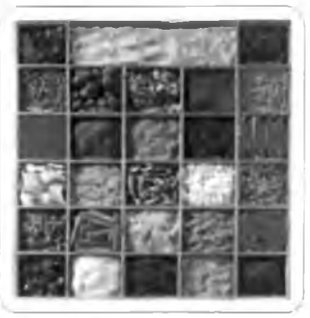

Horticulture Sector

Investigation No.1 RPF II

1. Project Code	:	**PHT/01-01-01-13/TNR(4)/ICAR**
2. Name of the Institute and Division		
Name and Address of the Institute	:	Kelappaji College of Agricultural Engineering & Technology, Kerala Agricultural University, Tavanur, Malappuram-679 573
Name of The Division/ Section	:	Dept. of Food and Agricultural Process Engineering
Location of the Project	:	KCAET, Tavanur
3. Project Title	:	**Processing and value addition of Jackfruit (*Artocarpus heterophyllus* L.)**
4. Priority Area	:	**03 Process**
Research Approach	:	04Technology transfer
5. Duration of the Project		
Date of Start of the Project	:	2013
Likely Date of Completion of the Project	:	2015
Period for which Report Submitted	:	2013-14
6. Summary of Achievements	:	Process protocol for blanching and canning of tender jack fruit
7. Key words	:	blanching, thermal processing, pasteurization, sterilization, canning
8. Principal Investigator		
Name	:	**Dr.Sudheer .K. P.**
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9. Introduction

The jackfruit is an important Indian seasonal fruit grown in limited areas (about 26,000 ha) across the country. It is a nutritious fruit, rich in vitamins A, B and C, potassium, β carotene, calcium, iron, proteins and carbohydrates. The highly perishable nature as a result of its inherent composition and textural characteristics has limited its storage for a longer time. The lack of proper postharvest knowledge during harvesting and storing contributes to the considerable wastage of the fruit yearly. Hence it is necessary to develop or to standardize a postharvest technology for prolonging the shelf life without significant alterations in the quality attributes. Development of processing and storage technologies like blanching and thermal processing facilitates the exploitation of the market potential of jackfruit by making them available to the consumers in a ready to eat or cook form throughout the year.

The improvement on tender jackfruit blanching treatment application, prior to canning, is required aiming at product's quality improvement. As the research on jackfruit has not been much discussed in the literature, the present study focuses on the optimisation of blanching process, specially blanching time which extends the shelf life without much alteration in nutritional and organoleptic qualities of the canned jackfruit. The aim of the present study was to evaluate enzyme inactivation as well as colour and texture changes during hot water blanching treatments. The overall results will help to define optimal hot water blanching conditions (blanching time, preservative and its pre-treatment concentration levels of tender jackfruit) for maximum quality retention in a canned tender jackfruit product development.

10. Objectives

1) To standardize the blanching process for tender jack fruit.
2) To standardize the thermal processing of tender jack fruit.
3) Storage studies and quality evaluation of thermally processed tender jack fruit
4) Development of a multipurpose fruit cutter

11. Technical Programme

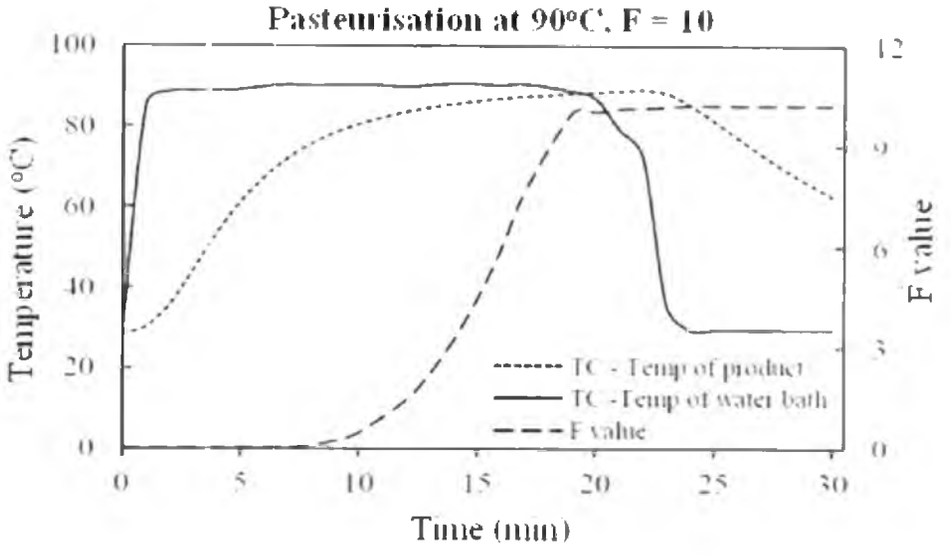
1) Standardization of thermal process time (Pasteurisation and Sterilisation)
2) Standardization of preservative for thermal processing
3) Shelf life study of thermally processed (canning and retort pouch) tender jackfruit

12. Progress in brief

Blanching of tender jackfruit (Varikka variety) was done in a hot water blancher at 100°C for a period of one minute which was standardized on the basis of enzyme inactivation (hydrogen peroxide test), texture and colour. The blanching treatment with 0.3% citric acid at this time temperature combination showed a better texture and colour.

After the standardization of blanching time and blanching treatment, experiments were conducted to optimize the thermal process. For this samples were prepared by dipping in 0.1% potassium metabisulphate solution for 15 minutes using 2 kg of solution per kg of bulbs to prevent browning .The samples were then sealed in cans by providing suitable headspace. The sealed cans were subjected to pasteurization and sterilization process. In pasteurization, the blanched samples were treated at 90°C for F values 8 and 10 and 100°C for F values 8 and 10 were determined. Similarly, time required to heat the product for sterilization at 110°C for F_0 values of 1 and 2 and 121°C for F_0 values of 1 and 2. Finally suitable thermal processes (pasteurization (T_p) and sterilization (T_s) time- temperature combinations) were optimized based on the results of textural, colour and microbial analysis. The combined results of microbial, texture and colour analysis suggested that pasteurization at a temperature of 90°C for F value 10 (19 minutes) and sterilization at 121°C for F_0 1 (38 minutes) is safe and may be used as an optimum thermal process for canned tender jackfruit.

Fig.1.1. Heat Penetration Curve Time for Thermal Process Pasteurisation



Thermally processed samples were then kept for shelf life studies with replications. Storage studies of the thermally processed canned tender jackfruit were conducted and different quality parameters like TSS, Titrable acidity, pH, Firmness, Toughness were analyzed. The effect of different thermal treatments viz., pasteurization and sterilization respectively on textural properties (Table 1) of the canned tender jackfruit shows that the firmness and toughness were decreased with increase in thermal process, time and temperature. Among the pasteurization treatments, maximum value of 68.48 ± 0.49 N and 63.95 ± 0.553 N.sec for firmness and toughness respectively were recorded for the treatment at 90°C for F value 10 (TP2). Similarly, in sterilization, the maximum value for firmness and toughness were 15.29 ± 0.453 N and 6.78 ± 0.349 N.sec respectively for samples processed at 121°C for F0 value 1 (TS3). As against the expectation, the value of TS3 was sufficiently greater than that TS2. The treatment of low temperature for long time adversely affected the texture of the product which resulted in the lower values of texture for TS2.

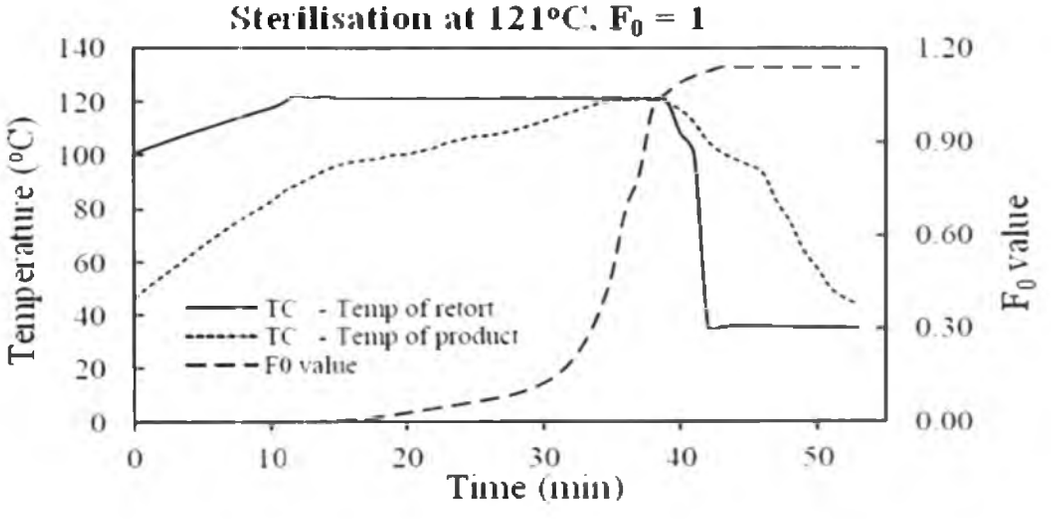


Fig.1.2. Heat Penetration Curve Time for Thermal Process Sterilisation

Table 1.1 Effect of pasteurization and sterilization on texture and colour

Treat-ment	Texture attributes		Colour attributes		
	Firmness	Toughness	'L'	'a'	'b'
Fresh	82.97 ± 1.136	185.10 ± 0.812	60.32 ± 0.01	-1.35 ± 0.06	16.09 ± 0.01
TP2	68.48 ± 0.49	63.95 ± 0.553	50.49 ± 0.25	0.46 ± 0.06	15.88 ± 0.55
TP4	53.49 ± 0.715	43.04 ± 1.04	50.42 ± 0.78	2.28 ± 0.24	11.79 ± 0.18
TS2	5.46 ± 0.884	3.38 ± 0.619	37.84 ± 1.44	15.59 ± 0.27	8.39 ± 0.22
TS3	15.29 ± 0.453	6.78 ± 0.349	48.76 ± 2.71	5.28 ± 0.21	10.77 ± 0.36
TS4	4.46 ± 0.943	2.73 ± 0.172	38.61 ± 1.11	15.83 ± 0.26	8.36 ± 0.06

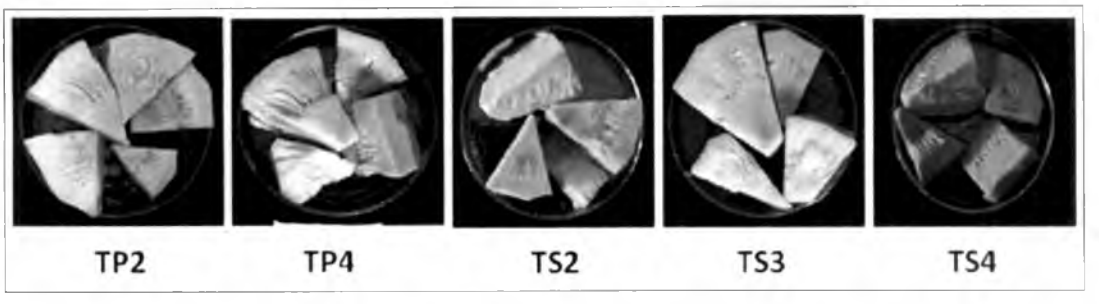


Fig. 1.3. Effect of thermal processing on colour of tender jack fruit

Thermal processing brought about variations in colour with Hunter colour measurements (Table 1.1) inferred that colour variation was higher in case of sterilization than pasteurization. Among the pasteurized treatments, the colour values of TP2 were comparatively nearer to fresh sample. Similarly in case of sterilized samples, TS3 showed a minimum ΔE value of 14.41 ± 2.22. While increasing the processing time, 'L' and 'b' values were decreased, while slight loss in greenness by increment in 'a' value was noted. The combined results of microbial, texture and colour analysis suggested that pasteurization at a temperature of 90°C for F value 10 (19 minutes) and sterilization at 121°C for F_0 1 (38 minutes) is safe and may be used as an optimum thermal process for canned tender jackfruit.

The storage study of canned tender jackfruit with different preservatives based on the quality attributes was examined. A significant difference in the quality attributes value was noted for sterilization and pasteurization processes except for crude fibre content. The TSS value decreased during the initial stage of storage due to the leaching of some of the soluble solids in water. Minimum TSS values were obtained for samples pasteurized in citric acid solution and maximum, for samples sterilized in brine solution. The titrable acidity of canned tender jackfruit (Fig.1) exhibited a decreasing trend, but value of titrable acidity was higher in samples which were preserved in citric acid or combination of citric acid with KMS. Later, an exponential decay was noted after 30 days of storage due to utilisation of citric acid during hydrolysis of polysaccharides and non-reducing sugars.

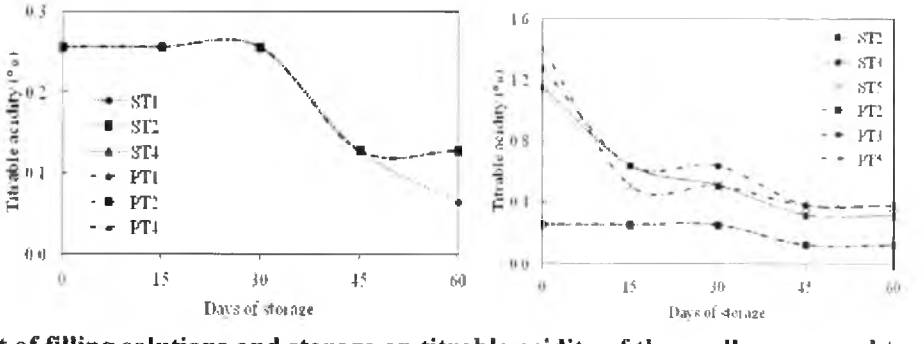


Fig.1.4 Effect of filling solutions and storage on titrable acidity of thermally processed tender jackfruit

Since acidity lowers the pH value, its value was low in samples having citric acid. The mean values of ascorbic acid content significantly decreased from 6.09 ± 0.78 to 5.92 ± 0.87 and 6.13 ± 0.75 to 5.97 ± 0.83 mg/100 g for sterilized and pasteurized tender jackfruit during storage. The losses in ascorbic acid may be due to high temperature and light during storage. The losses were reduced in samples having potassium metabisulphite due to better anti-oxidant property of KMS. The firmness and toughness were low in sterilized samples as compared with pasteurized samples. The mean values of firmness and toughness decreased from 2.40 ± 0.16 to 2.07 ± 0.22 N, 37.51 ± 1.13 to 33.9 ± 0.42 N and 4.67 ± 0.93 to 2.27 ± 0.27 N.sec, 78.45 ± 1.72 to 58.46 ± 1.7 N.sec for both sterilized and pasteurized tender jackfruit respectively. The Hunter parameters ('L', 'a', 'b') of canned jackfruit were investigated. The 'L', 'a', 'b' values of fresh sample were 70.62, -1.15, 15.185 9.61, -0.17, 14.69 and that of sterilized and pasteurized samples were 54.16, 9.95, 13.06 and 74.93, 0.95, 14.83 respectively. From the colour analysis (Fig.1.3) it can be seen that the samples pasteurized with citric acid as preservative was better in appearance over the sterilized samples.

13. Specific output : (i). Blanching process for tender jack fruit optimized.
(ii). Standardized the canning process protocol for tender jackfruit

14. Publications and Material Development :

1. Pritty. S. B, K. P. Sudheer., J. Bindu, and Anu.V. 2013. Safety and quality aspects of Thermally Processed Tender Jackfruit (*Artocarpus Heterophyllus* L.). In: *Proceedings of International conference on food technology: Ncoftech edition III*, January 4th to 5th 2013, at Indian Institute of Crop Processing & Technology, Thanjavur.
2. Pritty. S. B, and K. P. Sudheer. 2014. Thermal process optimization for tender Jackfruit (*Artocarpus Heterophyllus* L.). In: *Proceedings of XXVI*th *Kerala Science Congress*, 28th to 31st January, 2014, held at Kerala Veterinary & Animal sciences University, Pookod, Wayanad, Kerala, India.
3. Pritty S B, K. P. Sudheer., and J. Bindu. 2012. Optimization of blanching process for tender jackfruit (*Artocarpus heterophyllus* L.), *Indian Journal of Dairy & Biosciences, Vol. 23.*
4. Pritty. S. B, K. P. Sudheer and J. Bindu. 2012. Standardisation of process parameters for safe ready to cook jackfruit. *In: Proceedings of International Workshop on Strategies in Value Addition and Safety Aspects Pertaining to Dairy and Food Industry* on 15th and 16th March, 2012 at Madras Veterinary College, Vepery, Chennai.
5. Pritty. S. B, K. P. Sudheer., and J. Bindu. 2012. Thermal process optimization for jackfruit (*Artocarpus heterophyllus* L.). *In: Proceedings of Foodxplore-11, National seminar on Emerging technologies in food processing for ensuring food safety and quality*, during October 14th -15th, Tamilnadu Agricultural University, Coimbatore.
6. Pritty S. B, K. P. Sudheer., Santhi M. M, Divyasree P. S. and Anu S. C. 2014. Development and quality evaluation of canned tender jackfruit (*Artocarpus heterophyllus* L.), Proceedings of the International symposium on jackfruit and breadfruit of the tropics: genetic diversity, management, value addition and marketing strategies during may 15th to 16th, 2014, held at UAS, Bangalore.

15. Infrastructural Facilities Developed : Blancher, Retort

Signature of the Project Investigator :

Co-investigator :

Signature & Comments of the Head of the Department :

Investigation No.2

RPF II

1. Project Code	:	**PHT/02-02-04-13/TNR(4)/ICAR**
2. Name of the Institute and Division		
Name and Address of the Institute	:	Kelappaji College of Agricultural Engineering & Technology, Kerala Agricultural University, Tavanur, Malappuram-679 573
Name of The Division/ Section	:	Dept. of Food and Agricultural Process Engineering
Location of the Project	:	KCAET, Tavanur
3. Project Title	:	**MAP of edible wax coated passion fruit**
4. Research Approach	:	**02 Processing Equipment**
5. Duration of the Project		
Date of Start of the Project	:	2013
Likely Date of Completion of the Project	:	To be continued
Period for which Report Submitted	:	2013-14

6. Summary of Achievements

A wax applicator was fabricated and initial testing was conducted with passion fruit to evaluate its performance. The capacity of wax applicator was found to be 250 kg/hr. The fruits collected in the collecting tray after coating, were not damaged which may be due to the absence of bruising between the fruits due to the presence of rollers covered with nylon bristles which provided a cushion effect. An edible wax formulation was developed by mixing bee wax and rice bran oil. Standardization of edible wax formulation based on bee wax, and bran oil for passion fruit was also done. During the evaluation it was found that the conveying length is not sufficient to uniformly coat the wax over the fruits. To improve the efficiency, the number of rollers in the machine has to be increased from six to nine. The fabrication work of the modified wax applicator is completed.

7. Key words	:	Waxing applicator, Edible wax, passion fruit
8. Principal Investigator		
Name	:	**Dr.Sudheer .K. P.**
Designation	:	Associate Professor
Division/Section	:	Dept of F & APE
Location	:	KCAET, Tavanur
Co-Investigator		
1. Name	:	**Dr. Santhi Mary Mathew**
Designation	:	Professor
Division/Section	:	Dept of F & APE
Location	:	KCAET, Tavanur

9. Introduction

Though India is one of the largest producers of fruit and vegetables, it processes only less than 2.5% of the huge production as compared to 70-83% in advanced countries. According to the Task Force Report (2011), the post harvest losses of fruits and vegetables in India is estimated to be 25-35% of the total production which valued over Rs.50,000 crores annually.

Passion fruit (*Passiflora edulis*), a tropical fruit species, has become a popular addition to some diets. Passion fruit is either eaten fresh or used in commercial juice production. Juice of the fruit is a good source of vitamins A and C, and its aroma and flavour make pleasant contributions to drinks and desserts. Apart from these, passion fruit has a rich medicinal value, is rich in calories and has a high dietary fibre.

The high perishability of the passion fruit reduces its post harvest conservation and availability, mainly for fresh consumption. These losses of quality and commercial value occur due to the high respiration and loss of water. Plastic film will reduce the fresh weight loss and fruit wilting. Fruits and vegetables coated with wax look better and exhibit improved shrivelling control.

Hence this work is proposed to evaluate the influence of a modified atmospheric storage and edible wax emulsion coating and its interaction on the shelf life of passion fruit.

10. Objectives

1) To standardize edible wax formulation based on bee wax, rice bran oil.
2) To standardize a Modified Atmosphere Packaging (MAP) by understanding the gas kinetics and physiology of passion fruit.
3) To evaluate the post harvest behavior of passion fruit during storage and handling by measuring the quality parameters.

11. Technical Programme

1) Standardization of edible wax formulation for passion fruit
2) Modified Atmosphere Packaging of passion fruit
3) Shelf life study of MA packed passion fruit

12. Progress in brief

Passion fruit is a tropical fruit which is extensively used in juice processing. The fruit is highly perishable and losses its quality immediately after the second day of harvest. The post harvest loss in quality and commercial value is due to the intense respiratory activity and significant moisture loss. Hence a study was undertaken to develop a wax applicator to extend the shelf life of passion fruit by adopting the post harvest technologies.

Bee wax which is having a melting point of 62-64^{0}C along with a vegetable oil (rice bran oil) was selected as a base to prepare the wax emulsion. Various concentrations of bee wax in rice bran oil were tested to obtain an emulsion which is not solidified at room temperature. After the preliminary studies, the wax to oil ratio was standardized as 1: 100 and which was used for coating the fruits. Prior to development of a wax applicator, the important engineering properties of passion fruit like sphericity, surface area, angle of repose were studied. The angle of inclination of the machine is considered as the angle of repose of the fruits. Based on the physical properties of passion fruit, a wax applicator was designed with a principal objective to apply a uniform and complete impervious coating to each fruit in a continuously moving stream of fruits. The major parts of the machine are Feed hopper, tank, power source, rollers and brushes, collecting tray, wax supply system and main frame.

Feed hopper of size 36 x 18 x 33 cm fixed with an incline slightly at an angle of 10^0, which is based on sphericity and angle of repose of fruits. The tank of capacity 5l was fixed in the bottom of the mainframe and it is designed in such a way to collect the excess wax after the application. A single phase electric motor (12V) was used to drive the main shaft. Three perforated rollers and brushes are used to transfer the excess wax

sprayed over the fruits to the tank and 3 roller brushes to ensure uniform application of wax and to avoid bruising of fruits. A rectangular collecting tray will collect the coated fruits. A centrifugal pump helps in transferring the wax from the tank to the spraying tube which is having a number of holes for spraying the wax.

Figure 2.1 First Model

Figure 2.2 Second Model

The capacity of wax applicator was found to be 250 kg/hr. Initial testing of wax applicator was conducted with passion fruit to evaluate its performance. On testing, the coating efficiency was less due to the insufficient conveying length to uniformly smear/coat the wax over the fruits. Hence to improve the efficiency, this length was increased and the number of rollers was also increased from six to nine. Fabrication work of the modified wax applicator was completed and the machine is ready for testing. Initial testing of the machine was conducted with yellow passion fruits. However detailed testing will be will be conducted according to the availability of passion fruit in the next season.

The fruits were wax coated and kept in low density polyethylene (LDPE) bags of 200 gauge (50 µm) and 400 gauge (100 µm) thickness with different sets of perforations *viz.*,0.5%, 1% and 2%. Also, a set of fruits were kept in the non perforated bags. The treatments were: wax alone (T0), wax + LDPE 400 gauge with 2% perforation (T1), wax + LDPE 400 gauge with 1% perforation (T2), wax + LDPE 200 gauge with 2% perforation (T3), wax + LDPE 200 gauge with 1% perforation (T4), wax + LDPE 200 gauge with 0.5% perforation (T5), wax + LDPE 200 gauge without perforation (T6), Control (T7). All these samples were kept in a cold condition (7°C, 90% RH).

The postharvest behaviour during storage of passion fruit was tested periodically in an interval of 7 days for about a month. The appearance of the fruits were analysed visually. The physiological loss in weight (PLW) (%), total soluble solids (TSS) (°Brix), titrable acidity (%) and ascorbic acid (mg/100ml) were determined as per the standard methods. The external appearance of the fruits declined with storage time. This may be due to the loss of moisture. This was clear from fig. 2.3 that, there was no shrivelling in the case of fruits in T6. It resembles as if it was just harvested. This was due to the combined action of wax and LDPE bags. The fruits in T7 (control) shrivelled and decayed as there was no external barrier to prevent the moisture loss.

The PLW increased consistently with the maximum loss in weight in control (T7) with 52.32% whereas, the minimum loss in weight (0.99%) was found in wax coated fruits and kept in LDPE 200 gauge bags without perforation (T6) after the fourth week of storage (Fig.2.4). This may be due to the combined

action of wax and LDPE bags in which the coating plugs the opening of the fruit skin surface thereby lowering the rate of respiration and transpiration and the LDPE bags offers some resistance to the exchange of gases. It was also noted that the PLW of the control exceeded 12% after the second week of storage, thus reducing its consumer acceptability.

During the storage period, the TSS increased and titrable acidity, ascorbic acid and firmness of the stored fruits decreased. This was due to the ripening of the fruits. The lowest TSS was noted in T6 with 14.06° Brix after the fourth week of storage (Table. 2.1). This was perhaps due to the lowered respiration rate. The highest TSS of fruits were found in T7 with 19.4° Brix which might be due to higher rate of respiration and evaporation.

It was also clearly revealed that the minimum decrease in acidity (5.4%) was noted in T6. The acidity in T6 was lower because of the retarded ripening due to the MA created by the wax and the LDPE bags. The ascorbic acid content was found to be lower (20.31 mg/100 ml) in T6 yet the higher (24.91 mg/100 ml) was observed in T7. The variation in ascorbic acid may be due to the slow down in respiration created by the MA of the wax and the plastic packaging fruits.

The maximum firmness (69.32 N) was observed in T6. The variation in acidity, ascorbic acid and firmness may be due to the slow down in respiration created by the MA of the wax and the plastic packaging fruits. This may be due to the creation of modified atmosphere by both wax and LDPE bags. From the results obtained, the samples kept in non-perforated bags lasted upto 40 days, whereas the fruits kept as control lasted for only 10 days. Thus by modifying the respiration rate, the coating and LDPE bags delayed the ripening process, thereby extending the shelf life and maintaining the quality of the fruits.

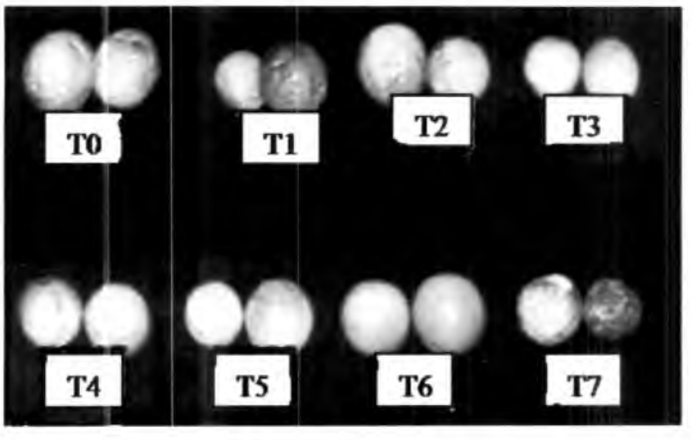


Fig. 2.3 Difference in external appearance of fruits

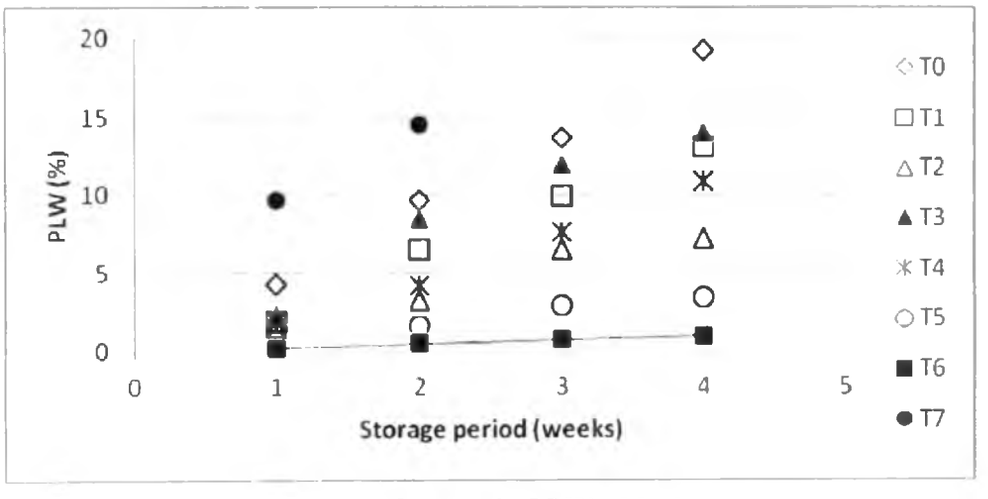


Fig. 2.4. Change in PLW of fruits

Table. 2.1 Change in TSS, titrable acidity, ascorbic acid and firmness of passion fruits after the fourth week of experimentation

Treatments	TSS (° Brix)	Titrable acidity (%)	Ascorbic acid (mg/100ml)	Firmness (N)
T0	16.40	4.15	24.40	46.11
T1	16.07	4.61	23.38	64.30
T2	15.93	4.78	22.89	46.34
T3	16.40	4.41	23.91	60.09
T4	16.00	4.36	23.91	67.64
T5	15.60	5.23	21.90	50.88
T6	14.40	5.40	20.39	69.32
T7	19.40	4.02	24.91	31.51

13. **Specific output:** A wax applicator was developed with sufficient conveying length for coating the passion fruit.

14. **Publications and Material Development:**

1. Sudheer. K. P and R. S. Madhana, 2012. Innovations in Packaging of fruits and Vegetables, *In: Proceedings of International Workshop on Strategies in Value Addition and Safety Aspects Pertaining to Dairy and Food Industry* on 15th and 16th March, 2012 at Madras Veterinary College, Vepery, Chennai.
2. Alfiya, P. V, Sudheer, K.P.. 2013. Effect Of Postharvest Treatments and Modified Atmosphere Package on Shelf Life Extension of Passion Fruit. *In: Proceedings of International conference on food technology: Ncoftech edition III*, January 4th to 5th 2013, at Indian Institute of Crop Processing & Technology, Thanjavur.
3. Madhana S.R. and K. P. Sudheer. 2014. Effect of edible coating on the quality parameters of passion fruit (Passiflora edulis). In: *Proceedings of XXVIth Kerala Science Congress*, 28th to 31st January, 2014, held at Kerala Veterinary & Animal sciences University, Pookod, Wayanad, Kerala, India.
4. Madhana S.R. and K. P. Sudheer. 2013. Effect of LDPE bags on the physio-chemical characteristics of passion fruit (*Passiflora edulis*).. *In: Proceedings of International conference on food technology: Ncoftech edition III*, (ISBN 978-81-926250-0-3) January 4th to 5th 2013, at Indian Institute of Crop Processing & Technology, Thanjavur.
5. Sudheer K.P., Supriya M R., Hima J, Alfiya P.V., and Chinchu M. 2014. Effect of edible coating and modified atmospheric packaging on shelf life of fruits and vegetables, In: *Proceedings of the XXVIIth National Convention of Agricultural Engineers* on 22nd and 23rd of February, 2014, Thiruvananthapuram, Kerala.
6. Madhana S.R. and K. P. Sudheer. 2012. Development and evaluation of a wax applicator for Passion Fruit (*Passiflora edulis*)". In: *Proceedings of the Dairy and food industry Conference 2012 on Quality and safe food for greener tomorrow'*, College of Veterinary and Animal Sciences, Kerala Veterinary and Animal Sciences University, Mannuthy.

15. **Infrastructural Facilities Developed** : **Wax applicator**

Signature of the Project Investigator :

Co-investigator

Signature & Comments of the Head of the Department :

Investigation No.3 RPF III

1. Project Code : **PHT/02-02-02-09/TNR (4)/ICAR**

2. Name of the Institute and Division

Name and Address of the Institute : Kelappaji College of Agricultural Engineering & Technology, Kerala Agricultural University, Tavanur, Malappuram-679 573

Name of The Division/ Section : Dept. of Food and Agricultural Process Engineering

Location of the Project : KCAET, Tavanur

3. Project Title : **Development of banana (CV *Nendran*) peeler for making chips**

4. Priority Area

Research Approach : 04 Technology transfer

Date of Start of the Project : 2009

Likely Date of Completion of the Project : Completed

Period for which Report Submitted : 2013-14

6. Summary of Achievements

A third model of motorized banana peeler was developed. However the developed machine was less efficient in operation and resulted in material loss. Effect of heating of green Nendran banana in hot water as a pre-treatment was tried to enhance the efficiency of banana peeling. The pre heating was done in hot water at 100°C for 30 seconds and 1 minute for the easy removal of banana peel. The efficiency of peeling, material loss, moisture content and oil retention after frying were estimated and compared with the control sample.

7. Key words : Banana, peeler

8. Principal Investigator

Name : **Dr.Sudheer .K. P.**

Designation : Associate Professor

Division/Section : Dept of F & APE

Location : KCAET, Tavanur

Co-Investigator

1. Name : **Dr. Santhi Mary Mathew**

Designation : Professor

Division/Section : Dept of F & APE

Location : KCAET, Tavanur

9. Introduction

Banana chips making has not emerged as a large scale industry though it as a large market potential because of the lack of appropriate mechanical systems for pealing and slicing. The government has already plant for boosting the production of banana both for domestic consumption and exports. At present, it is a small scale industry in Kerala and the product is in high demand in India and abroad, especially in Gulf countries. There is a great scope for further development of this industry by modifying the product quantity. The efficiency of the conventional system is less and the process is time consuming and labour intensive.

Also, the existing conventional methods do not produce chips of uniform size. Development of an efficient banana peeler can definitely contribute towards quality product and fetch better price and thus improve the financial status of the *Nendran* banana grower in the state, which perhaps can create a positive influence in state and national economy.

10. Objectives

1) Development of a motorised banana peeler for the production of chips
2) Evaluation of the developed banana peeler

11. Technical Programme

1) Development of a motorised banana peeler for the production of chips
2) Evaluation of its efficiency in terms of capacity, peeling efficiency and material loss

12. Progress in brief

As the previous model developed in this centre is not versatile; the Council suggested fabricating a motorized banana peeler. This machine makes use of three curved blades driven by three separate motors (DC motors: Specification: 12 V, 100 rpm). Fresh banana were manually guided to the peeling zone by three spring loaded pulleys arranged in a horizontal plane at 120° set apart. Three blades split the peel of banana into three sections and peeled banana will be collected in a tray below the feeding pulleys. The individual spring loaded pulleys permit the machine to accept different grades of banana, irrespective of its diameter or shape.

During the testing, it was observed that the efficiency of peeling is less due to the inefficiency of the cutting mechanism and the free downward movement of banana. Hence an extra spring loaded tool was developed and tested. While conducting studies with this model, material loss was reported and the peel removal was found to be very difficult. Hence the effect of pre-treatment (heating in hot water at 100°C for 30 seconds and 1 minute) for loosening the peel was studied. The efficiency of peeling was better for the samples preheated for 30 seconds with negligible material loss, without affecting the quality. After peeling, the effect of pretreatment on quality of chips were estimated based on moisture content, frying time and residual oil were estimated as per the standard procedure.

Table 3.1 Performance evaluation of third model peeler and Quality analysis of pre-treated banana

				Quality Analysis		
Hot water Treatment	Peeling efficiency (%)	Capacity (Kg/hr)	Material loss (%)	Moisture Content (%)	Frying time (minutes)	Residual Oil (%)
Control	54	16-20	12	17.36	4	30.1
30 seconds	62	19-22	8.5	20.0	5	28.2
1 minute	63	20-25	8.4	22.7	6	28.5

Figure 3.1 First Model

Figure 3.2 Second Model

Figure 3.3 Third Model

13. **Specific output:** The effect of pre-treatment on easy removal of banana peel was studied. The peeling found to be more efficient for the pre-heated samples with less material loss.

14. **Publications and Material Development** :

15. **Infrastructural Facilities Developed** :

Signature of the Project Investigator :

Investigation No. 4

RPF III

1. Project Code	:	**PHT/01-02-02-06/TNR (4)/ICAR**
2. Name of the Institute and Division		
Name and Address of the Institute	:	Kelappaji College of Agricultural Engineering & Technology, Kerala Agricultural University, Tavanur, Malappuram-679 573
Name of The Division/ Section	:	Dept. of Food and Agricultural Process Engineering
Location of the Project	:	KCAET, Tavanur
3. Project Title	:	Development of pilot plant for osmotic dehydration of green pepper
4. Priority Area	:	**03 Process**
Research Approach	:	04Technology transfer
5. Duration of the Project		
Date of Start of the Project	:	2009
Likely Date of Completion of the Project	:	Completed
Period for which Report Submitted	:	2013-14

6. Summary of Achievements

Even though the parameters for osmotic dehydration of green pepper were studied and reported in previous years, for the blanching process prior to osmotic dehydration, a hot water blancher and steam blancher were developed and studied. The blancher parameters were standardized and qualities of the dehydrated green pepper were studied in terms of retention of green colour and essential oil content.

7. Key words	:	Osmotic dehydration, green pepper
8. Principal Investigator		
Name	:	**Dr. Santhi Mary Mathew**
Designation	:	Professor
Division/Section	:	Dept of F & APE
Location	:	KCAET, Tavanur
Co-Investigator		
1. Name	:	**Dr.Sudheer .K. P.**
Designation	:	Associate Professor
2. Name	:	**Ms. Sreeja. R**
Designation	:	Assistant Professor
Division/Section	:	Dept of F & APE
Location	:	KCAET, Tavanur

9. Introduction

Green pepper is an important value added product, which is prepared from unripe but fully developed pepper berries which are artificially dried or preserved in brine solution. Annually, the availability of tender

green pepper is only for a period of two to three months. To assure round the year availability, green pepper could be better dehydrated and stored for a year or more and can be used at will by simple reconstitution. Dehydration of green pepper is usually carried out by blanching followed by drying. Many food industries employ different drying equipments such as freeze driers and tray driers. Being highly expensive such driers alone are not suitable for farmers or small-scale enterprises. Though sun drying is cheaper, it is unhygienic and time consuming. Hence there is a need for cheaper and quicker drying alternatives for rural areas. Osmotic dehydration is such a novel technique for the production of safe, stable, nutritious and tasty food. Osmotic dehydration is the method of partial removal of water from plant tissues by immersing it in an osmotic solution. Osmotic dehydration due to its energy and quality related advantages, is gaining popularity as a complimentary processing step in the chain of integrated food industry. After osmotic dehydration there is a need for secondary drying. It enhances the keeping quality and increases shelf life of the product which plays a very vital role in the market value of the product.

10. Objectives

1) Development of a steam blancher and a hot water blancher for the production rof dehydrated green pepper
2) To compare the performance of both the blanchers in terms of quality of dehydrated green pepper.

11. Technical Programme

1) To analyze the quality of the dehydrated green pepper produced by hot water blanching and steam blanching.
2) Compare the performance of both the blanchers in terms of quality of dehydrated green pepper

12. Progress in brief

Though the project has been completed with its committed objectives, blanching of green pepper prior to osmosis has to be conducted using the steam blancher as a substitute to the traditional blanching process. Accordingly, a steam blancher was fabricated and tested with green pepper. Even though it retains the green colour, there is a reduction in volatile oil. So it was decided to develop a hot water blancher as an alternate to steam blanching.

Fresh green pepper berries harvested 10-15 days before maturity were procured from the instructive farm of a progressive farmer at Tavanur were used for the study. These berries were separated from the spikes and cleaned manually. The initial moisture content was determined by the standard method (AOAC, 1975) and it was found to be 70% (wb). These samples were blanched using both hot water blancher and steam blancher.

For hot water blanching, the berries were blanched for 15 minutes at 100°C and immediately cooled. These berries were drained and spread on a cotton cloth for removal of surface moisture. In the case of steam blanching, it was blanched at 0.7 Kg/cm^2 (recommended steam pressure for spices) for 1, 3 and 5 minutes.

The osmotic dehydration of blanched berries was carried out in the osmotic dehydration plant using standardized conditions of 30% brine solution for 3 hours. Osmotic dehydration generally will not give a product of low moisture content to be considered shelf stable. The secondary drying at 50°C was carried out using a cabinet drier for both hot water and steam blanched samples. The colour of dried product was recorded using Hunter lab colour flex meter and the values are represented as color difference (ΔE). Moisture content and volatile oil of the dried samples were estimated as per the standard procedure.

Treatment	Moisture content(%)	Volatile oil (%)	Colour(ΔE)
Control	9.80	2.01	4.50
Hot water blanching15min	9.10	1.81	6.25
Steam blanching 1 min	9.01	1.00	3.16

Table 4.1 Quality of hot water blanched and steam blanched green pepper

It can be observed that the percentage of oil content in the samples blanched in hot water blancher was higher than that of steam blanched samples.

13. **Specific output:** Developed a steam blancher and hot water blancher.

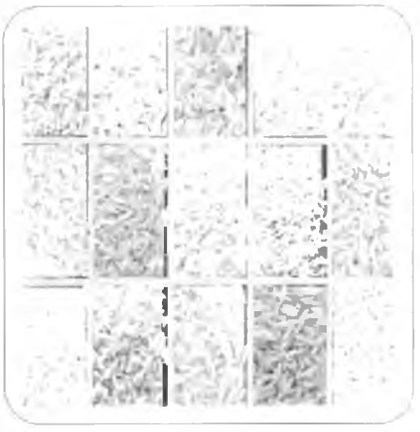
14. **Publications and Material Development** : **Nil**

15. **Infrastructural Facilities Developed** :

Signature of the Project Investigator :

Co-investigator :

Signature & Comments of the Head of the Department :


Food Grain Sector

Investigation No.5 RPF II

1. **Project Code** : **PHT/03-03-02-13/TNR (4)/ICAR**

2. **Name of the Institute and Division**

Name and Address of the Institute	:	Kelappaji College of Agricultural Engineering & Technology, Kerala Agricultural University, Tavanur, Malappuram-679 573
Name of The Division/ Section	:	Dept. of Food and Agricultural Process Engineering
Location of the Project	:	KCAET, Tavanur

3. **Project Title** : **Development of protocol for extruded RTE snack food from rice and banana**

4. **Priority Area** : **03 Process**
Research Approach : 04 Technology transfer

5. **Duration of the Project**

Date of Start of the Project	:	2013
Likely Date of Completion of the Project	:	2015
Period for which Report Submitted	:	2013-14

6. **Summary of Achievements** : An extruded Ready to eat (RTE) snack food product was developed out of starch based food products such as rice, and *Nendran* banana at optimized process parameters *viz*; temperature, screw speed, flow rate, and moisture content. The nutritional, engineering, and textural quality parameters of the extruded product evaluated.

7. **Key words** : RTE food, extrusion

8. **Principal Investigator**

Name	:	**Dr.Sudheer .K. P.**
Designation	:	Associate Professor
Division/Section	:	Dept of F & APE
Location	:	KCAET, Tavanur

Co-Investigator

1. Name	:	**Dr. Santhi Mary Mathew**
Designation	:	Professor
2.Name	:	**Ms. Sreeja. R**
Designation	:	Assistant Professor
Division/Section	:	Dept of F & APE
Location	:	KCAET, Tavanur

9. Introduction

Snack foods play very important role in the diet of the modern consumer due to time constraints and due to the lack of knowledge to prepare traditional meals. In India, several ready-to-eat (RTE) products are available in the market. The RTE foods are prepared by extrusion cooking, puffing, popping, flaking, frying, toasting, etc. It includes extruded snacks, puffed cereals, popcorns, rice flakes, potato chips, French fries and Indian home made products like papads, kurdai, chakali, etc. which may be consumed after frying or roasting.

Nutritionally secure RTE food product has immense importance in this era. Rice which is the staple food of our state has high digestibility. It is low in fat, low in cholesterol, high in starch, and has a high nutritional content. Rice can contribute significantly to vitamin and mineral intake, although the contribution to micronutrient intake will depend on the proportion of germ, bran and endosperm consumed. So it is selected as one of the raw material for developing the product.

Banana is a tropical fruit, a large berry which is handy and healthy. Banana consists of potassium, magnesium and also fibers. They are low in calories, fats, sodium and much of its fibers are soluble which helps in lowering the overall cholesterol. So it is also preferred as one of the mixing material. The main nutritional value of roots and tubers like Cassava lies in their potential ability to provide one of the cheapest sources of dietary energy, in the form of carbohydrates, in developing countries. The high yields of most root crops ensure an energy output per hectare per day which is considerably higher than that of grains. So a product out of this will be highly nutritious and beneficial for the present era.

A snack food with a balanced mix of fibers, proteins, carbohydrates, vitamins and minerals will ensure food security and safety. Hence the present study focusses on developing a low cost, nutritious, new RTE food product by blending rice with banana.

10. Objectives

1) To standardize the extrusion process parameters.
2) To standardize the composition of RTE food from rice and banana.
3) To study the shelf life of extruded RTE snack food under Modified Atmospheric Package.

11. Technical Programme

1) Standardization of extrusion process parameters
2) Standardization of combination of ingredients for the new RTE snack food
3) Shelf life studies of the RTE food under MAP
4) Quality evaluation of the RTE food

12. Progress in brief

Broken rice collected from the nearby Modern rice mill along with banana collected from the local market were used for the preparation of extruded snack. Rice: banana combinations were selected in the ratios of R_{60}:B_{40}, R_{70}:B_{30}, R_{80}:B_{20}, R_{90}:B_{10} with an increased amount of rice and decreased amount of banana powder. Initial trials were conducted on extrusion of rice and banana flour mixture at various proportions after conditioning the mixture to 16% moisture content. Extrusion trials were carried out in a single screw food extruder. Extrusion was carried out for these four different blends under different die zone temperatures of 170, 180, 190, 200°C with an extruder screw speeds of 80, 100 and 120 rpm. Quality of the extrudates assessed in terms of bulk density, expansion ratio, water activity, water absorption index, water solubility index and textural property (crispness) and browning index.

Extruded samples were packed in laminated aluminum pouches with nitrogen flushing and kept it for storage studies. In third month, the quality of the product was analyzed for different properties like bulk density, expansion ratio, water activity, water absorption index, water solubility index and textural property (crispness) and browning index. The variation in expansion ratio of extruded product at 80, 100 and 120 rpm at 170°C is shown in figure.

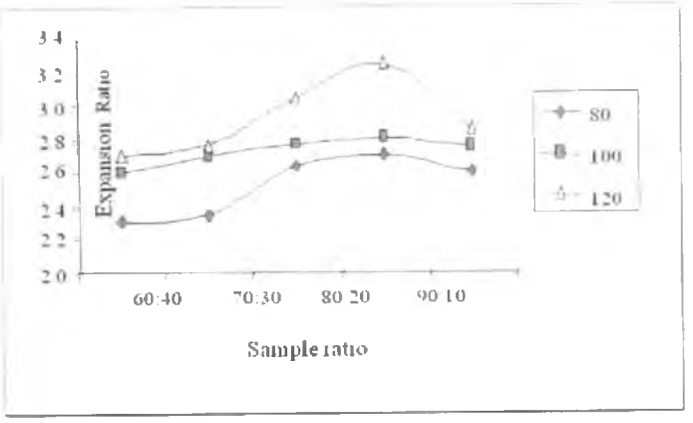


Fig.5.1 Variation in Expansion ratio of extruded products at 170°c

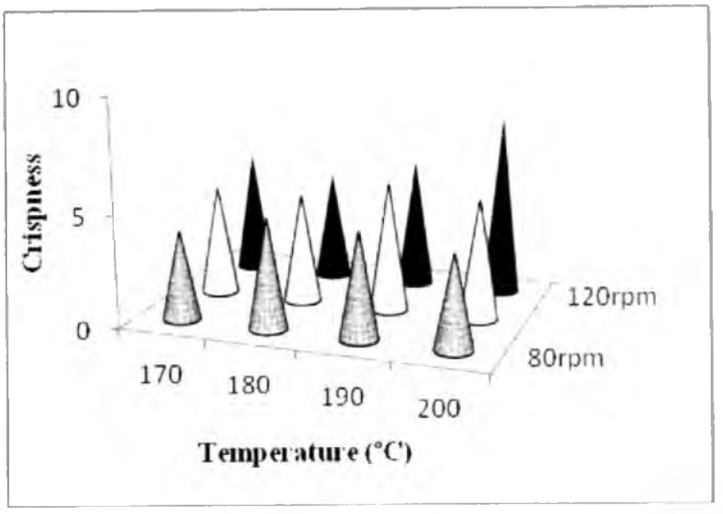


Fig.5.2. Variation in Crispiness after 3 months of storage

Table. 5.1. Quality parameters of the extruded product at 170° C after three month storage

Combination (%)	Screw Speed (rpm)	Bulk density (g/cm^3)	Expansion ratio	Water activity	Water absorption index (g/g)	Water solubility index	crispness	Browning index
$R_{60}:B_{40}$	80	0.33	2.60	0.60	18.44	2.20	2.10	32.3
	100	0.32	2.71	0.58	17.23	2.40	2.80	32.7
	120	0.30	2.79	0.54	16.23	4.97	2.90	40.5
$R_{70}:B_{30}$	80	0.30	2.60	0.69	14.66	2.44	2.50	29.0
	100	0.22	2.64	0.68	12.77	5.41	2.70	49.1
	120	0.19	2.85	0.66	10.99	6.20	3.10	41.3
$R_{80}:B_{20}$	80	0.25	2.45	0.63	13.33	4.90	3.30	26.5
	100	0.21	2.50	0.62	12.91	7.82	3.30	28.4
	120	0.19	2.58	0.62	12.83	8.55	3.90	30.1
$R_{90}:B_{10}$	80	0.34	2.90	0.62	14.04	8.58	3.30	22.6
	100	0.33	2.88	0.61	12.14	10.85	3.70	21.9
	120	0.32	2.90	0.61	10.44	12.94	5.30	18.8

Table 5.2. Quality parameters of the extruded product at 180° C after three month storage

Combination (%)	Screw Speed (rpm)	Bulk density (g/cm^3)	Expansion ratio	Water activity	Water absorption index (g/g)	Water solubility index	crispness	Browning index
$R_{60}:B_{40}$	80	0.31	2.63	0.55	17.67	5.22	2.50	36.70
	100	0.27	2.68	0.53	16.33	6.30	3.00	41.30
	120	0.25	2.82	0.52	12.82	7.01	3.20	41.40
$R_{70}:B_{30}$	80	0.23	2.76	0.67	11.82	3.64	2.50	30.40
	100	0.23	2.89	0.66	11.04	6.12	3.00	40.40
	120	0.20	2.95	0.65	10.91	8.54	4.00	42.90
$R_{80}:B_{20}$	80	0.23	2.45	0.61	13.06	4.63	3.20	31.00
	100	0.23	2.61	0.61	12.12	6.05	3.70	32.10
	120	0.20	2.73	0.61	11.71	11.46	4.50	30.40
$R_{90}:B_{10}$	80	0.30	2.89	0.61	12.30	11.31	5.20	24.00
	100	0.27	2.97	0.60	11.21	14.55	7.40	23.40
	120	0.27	3.03	0.59	11.07	15.56	7.90	25.70

Table. 5.3. Quality parameters of the extruded product at 190° C after three month storage

Combination (%)	Screw Speed (rpm)	Bulk density (g/cm^3)	Expansion ratio	Water activity	Water absorption index (g/g)	Water solubility index	crispness	Browning index
$R_{60}:B_{40}$	80	0.19	2.84	0.51	15.23	7.30	3.20	44.6
	100	0.16	2.85	0.47	13.89	8.09	3.70	44.2
	120	0.15	2.98	0.46	12.80	10.68	3.90	46.3
$R_{70}:B_{30}$	80	0.19	3.01	0.64	11.04	6.72	3.50	37.8
	100	0.18	3.05	0.63	10.98	8.81	4.50	39.9
	120	0.18	3.07	0.62	10.77	10.44	4.80	40.3
$R_{80}:B_{20}$	80	0.19	2.64	0.61	12.17	8.75	4.20	34.2
	100	0.19	2.86	0.61	10.89	16.28	4.80	28.9
	120	0.18	3.09	0.57	8.86	17.79	5.30	30.5
$R_{90}:B_{10}$	80	0.16	3.04	0.57	11.34	14.35	5.80	27.4
	100	0.15	3.17	0.56	11.28	17.46	7.40	22.8
	120	0.15	3.20	0.53	11.01	18.99	7.90	23.5

Table. 5.4. Quality parameters of the extruded product at 200°C after three month storage

Combination (%)	Screw Speed (rpm)	Bulk density (g/cm^3)	Expansion ratio	Water activity	Water absorption index (g/g)	Water solubility index	crispness	Browning index
$R_{60}:B_{40}$	80	0.24	2.82	0.55	16.46	2.58	2.60	45.4
	100	0.22	2.90	0.52	15.70	6.67	3.20	51.8
	120	0.18	2.93	0.51	14.26	8.81	3.50	40.7
$R_{70}:B_{30}$	80	0.20	2.71	0.65	11.73	7.65	3.50	39.3
	100	0.19	2.84	0.63	11.08	7.74	3.90	44.0
	120	0.19	3.06	0.64	11.02	8.54	4.30	47.2
$R_{80}:B_{20}$	80	0.20	2.80	0.61	12.85	4.93	3.20	33.7
	100	0.19	2.83	0.60	12.71	9.98	3.60	31.1
	120	0.19	2.90	0.61	12.12	12.57	4.90	29.6
$R_{90}:B_{10}$	80	0.23	2.95	0.59	12.01	14.34	4.20	25.2
	100	0.21	2.97	0.58	10.25	16.70	4.50	28.6
	120	0.20	3.07	0.58	9.50	17.11	6.20	22.1

Selection of the extrudates was done with expansion ratio above 3.0 and bulk density upto $0.18g/cm^3$. Based on this, 10 samples were selected for further studies.

13. **Specific output:** Process parameters were standardised for the RTE extruded product from banana and rice

14. Publications and Material Development :

1. Aneeshya K.K.S, K. P. Sudheer, and T. J. Sheriff. 2013. Textural properties and economic feasibility of an extruded RTE snack from starch based food products. In: *Proceedings of XXV^th Kerala Science Congress*, 29th January to 1st February, 2013, held at Technopark, Thiruvananthapuram, Kerala, India.(**Received the best poster award**)
2. Surya, S., K. P. Sudheer, E. Aneesa, H. Hridya, M. S. Sajeev, T. J. Sheriff. 2010. Effect of temperature on engineering properties of extrudate from Njavara rice and Nendran banana. In: *Proceedings of Kerala Science Congress*, January 2010, held at Peechi, Thrissur, India.
3. Aneeshya K.K.S., K. P. Sudheer. and T. J. Sheriff. 2013. Development of cassava and rice based expanded RTE snack food and its physical evaluation. *In:* Proceedings of International conference on food technology: Ncoftech edition III, *January 4th to 5th 2013, at Indian Institute of Crop Processing & Technology, Thanjavur.*
4. Aneeshya K.K.S., K. P. Sudheer. and T. J. Sheriff. 2012. Functional properties of an extruded RTE snack from starch based food products. *Proceedings of Global Conference on "Horticulture for Food, Nutrition and Livelihood Options"*, during May 28th to 31st 2012, held at Orissa University of Agriculture and Technology, Bhubaneswar.
5. Aneeshya K.K.S, K. P. Sudheer., and T. J. Sheriff. 2012. Effect of Extrusion process parameters on quality of carbohydrate based RTE snack food. *Proceedings of Dairy and food industry Conference 2012 on Quality and safe food for greener tomorrow* during 11th to 13th April, 2012 at College of Veterinary and Animal Sciences, Kerala Veterinary and Animal Sciences University, Mannuthy.

6. Aneeshya K.K.S, K. P. Sudheer., and T. J. Sheriff. 2012. Structural properties of a nutritionally rich cassava based extruded snack, *Proceedings of National Conference on Food Technological Interventions for health and nutrition security- "Nutrifood-2012"* during 15th to 16th March, 2012 at Department of Food Science, Periyar University, Selam, Tamilnadu.
7. Hridya, H., K. P. Sudheer, E. Aneesa, S. Surya, G. Padmaja . 2009. Effect of temperature on nutritional quality of extrudate from Njavara rice and Nendran banana. *Proceedings of 19th Swadeshi Science Congress*, December 2009, Thrissur, India.
8. Sudheer, K.P., E. Aneesa, H. Hridya, S. Surya., T. J. Sheriff. 2009. Effect of temperature on engineering properties and sensory quality of RTE food prepared from specialty rice and Nendran banana. *Proceedings of ICFOST on "Specialized Processed Foods for Health and Nutrition: Technology & Delivery"*, December 21st-23rd, 2009, Bangalore, India.

15. Infrastructural Facilities Developed : **Nil**

Signature of the Project Investigator :

Co-investigator :

Signature & Comments of the Head of the Department :

Investigation No.6

RPF II

1. **Project Code** : **PHT/03-02-06-14/TNR (4)/ICAR**

2. **Name of the Institute and Division**

Name and Address of the Institute	:	Kelappaji College of Agricultural Engineering & Technology, Kerala Agricultural University, Tavanur, Malappuram-679 573
Name of The Division/ Section	:	Dept. of Food and Agricultural Process Engineering
Location of the Project	:	KCAET, Tavanur

3. **Project Title** : **Fibre fortification of pasta using banana peel powder and evaluation of nutritional and physicochemical properties.**

4. **Priority Area**

Research Approach	:	04 Technology transfer

5. **Duration of the Project**

Date of Start of the Project	:	2013
Likely Date of Completion of the Project	:	2015
Period for which Report Submitted	:	2013-14

6. **Summary of Achievements**

Banana peel of matured Nendran variety was procured and pre-treated with 0.1%, 0.5% and 1% citric acid solution for 10 minutes to reduce enzymatic browning. After drying the peels, trials were conducted with combinations of wheat: banana peel powder, Maida: banana peel powder and wheat: Maida: banana peels powder as ingredients in various proportions. The pasta obtained was dark in color. In order to get lighter colored pasta, banana peels were treated with 0.3% citric acid followed by blanching at 100°C for 15 and 20 minutes to reduce enzymatic browning. Pasta was prepared with this banana powder along with wheat flour. The textural behavior of the product quality of pasta was assessed.

7. **Key words** : **Fortification, Pasta, Banana peel powder**

8. **Principal Investigator**

Name	:	**Mrs. Sreeja. R**
Designation	:	Assistant Professor
Division/Section	:	Dept of F & APE
Location	:	KCAET, Tavanur

Co-Investigator

1. Name	:	**Dr.Sudheer .K. P.**
Designation	:	Associate Professor
2.Name	:	**Dr. Santhi Mary Mathew**
Designation	:	Professor
Division/Section	:	Dept of F & APE
Location	:	KCAET, Tavanur

9. Introduction

Dietary fiber has been, for several years, the glamour ingredient in popular nutrition. Based on epidemiological evidence, lack of fiber in the diet has been impugned as a major risk factor for development of colon cancer, heart disease. diabetes and a variety of lesser ills. Animal experiments suggest that some components of the complex mixture of substances called fiber will reduce cholesterol levels to a modest extent and will inhibit atherosclerosis.

The peel of banana represents about 20% of the total weight of fresh banana and has been underutilized. Utilizing its high-added value compounds, including the dietary fibre fraction that has a great potential in the preparation of functional foods. A high dietary fibre content of banana peel (about 50 g/ 100 g) is indicative of a good source of dietary fibre.

Pasta, with its origin in Italy has gained wide popularity as a convenient and nutritionally palatable, low glycemic food. The pasta products have been fortified with suppliments from various high-protein sources to improve their nutritional properties. The object of this research is to evaluate the fortification of pasta with dietary fiber using banana peel powder. The fortified pastas were evaluated in relation to biochemical composition, cooking properties, textural characteristics and nutritional characteristics. Thus, the banana peel, a waste from banana flour industry can be utilized for the preparation of pasta with improved nutritional properties.

10. Objectives

1) Standardization of the effect of drying in the dietary fiber content of banana peel
2) Standardization of addition of banana peel powder to make fiber fortified pasta
3) Evaluation of nutritional and physico-chemical properties of fiber fortified pasta

11. Technical Programme

1) Optimization of blanching process of banana peel.
2) Development of fiber fortified pasta by adding banana peel powder and evaluation of nutritional and physic-chemical properties.
3) Development of fiber fortified pasta using the extracted dietary fiber from banana peel in collaboration with Bengaluru centre.

12. Progress in brief

Raw and matured Nendran variety of banana were procured from nearby market and peeled off using the banana peeler. The banana peels pre-treated and dried as explained below:

Moisture content determination

The moisture content of the peel sample was determined using oven drying method by keeping a small quantity of three samples of peels in the hot air oven at 100°C for 24 hours and found to be 80.2%.

Pre-treatments

250g of banana peels were thoroughly washed in distilled water followed by dipping in 0 1%, 0.5% and 1% citric acid solution for 10 minutes to reduce enzymatic browning. After draining it was sliced manually using clean knives into approximately 2X2 cm square pieces for uniform drying.

Drying studies

Weighed samples were spread on the perforated trays were dried in a cabinet drier at a temperature of 60 ± 1°C.An inbuilt digital temperature controller in the dryer maintained the air temperature within ± 1°C. The moisture content of the peel at hourly intervals was calculated from the weight loss of the sample during drying.

Preparation of peel powder

The dried peel slices were finely powdered with the help of a mixer grinder which was sieved through a clean sieve of 40 mesh screen to obtain fine banana peel powder. The powders were packed separately in LDPE covers and were sealed and kept in a refrigerator for further analyses.

Qualitative Analysis of banana peel powder

The stored peel powder was subjected to various tests to find out the crude fibre content, carbohydrate content and TSS. For the determination of these parameters, standard methods were adopted. The percentange of crude fibre was 43.05% and carbohydrate was 12.3%. The total soluble solids was determined by using the hand refractometer and was found to be 6.72° Brix.

Preparation of plane pasta

Initial trials conducted with combinations of wheat: banana peel powder, Maida: banana peel powder and wheat: Maida: banana peel powder as ingredients in various proportions. Three samples of pasta were produced from different compositions of flour and peel powder through cold extrusion process using pasta making machine (Make: La Monferrina, Italy; Model: P6).

Table 6.1 Composition of banana peel fortified pasta in initial trials

	Peel powder	Wheat flour	Maida	Total
S 1	15g (10%)	67.5g (45%)	67.5g (45%)	150g
S 2	15g (10%)	135g (90%)	0	150g
S 3	15g (10%)	0	135g (90%)	150g

Drying of pasta was done at room temperature for 24 hours and then packed and sealed in LDPE covers and sealed for further quality analysis.

The flowchart for the preparation of fibre fortified pasta is given below:

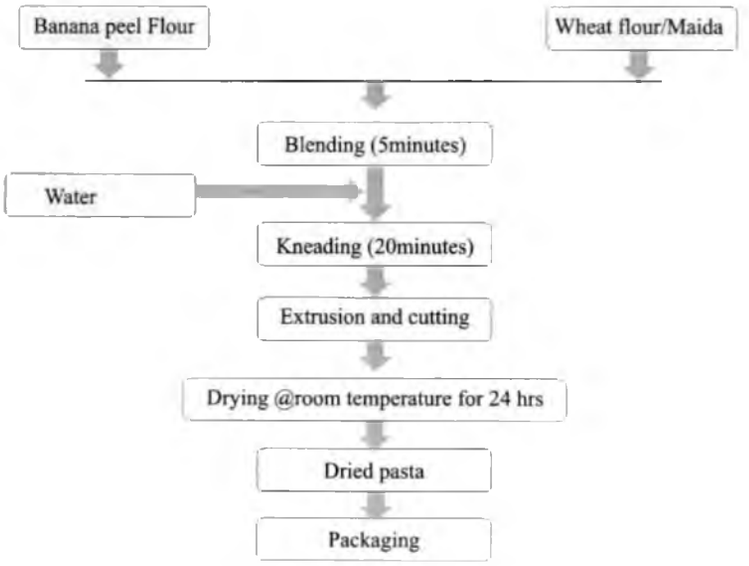


Figure 6.1 Extrusion of pasta

Figure 6.2 Pasta prepared in the initial trials

The pasta prepared was dark in color. This could be due to the enzymatic browning. In order to get lighter colored pasta, banana peels were treated with 0.3% citric acid followed by blanching at 100°C for 5min,10min, 15min and 20 minutes to reduce enzymatic browning. Inorder to ensure the inhibition of enzymes responsible for enzymatic browning, the chemical tests for peroxidase (Guaicol method) and catalase (bubble test) enzyme were done for all the time intervals. Based on the results from these tests, treatment of citric acid along with blanching at 100°C for 20 minutes was standardized in which the enzymes were completely inactivated.

Figure 6.3 Dried banana peel after standardization of blanching

Figure 6.4 Banana peel powder

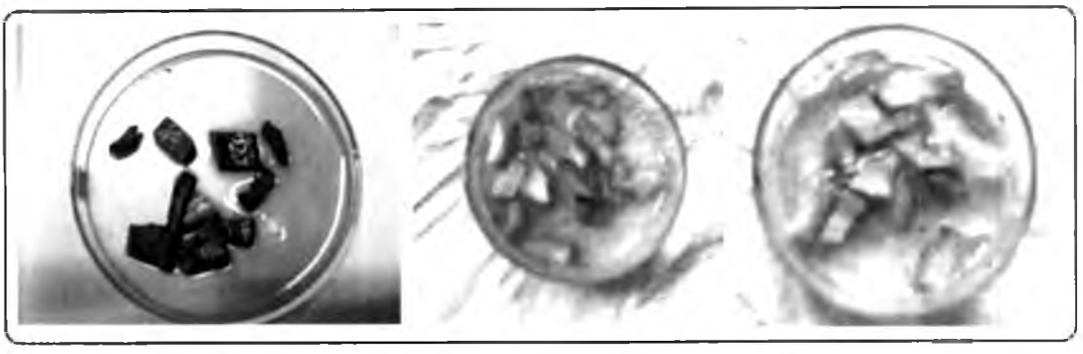


Figure 6.5 Results of chemical tests for enzyme activity

The prepared samples were dried, powdered and packed. Pasta was prepared with this banana peel powder (6% and 9%) along with wheat flour. The textural behavior of the pasta like firmness and total shearing force was assessed using texture analyzer.

Sample	Firmness (N) force (Nsec)	Total shearing
Pasta with 6% peel powder	36.48	39.2
Pasta with 9% peel powder	48.24	41.3

Table 6.2 Results of texture analysis of pasta

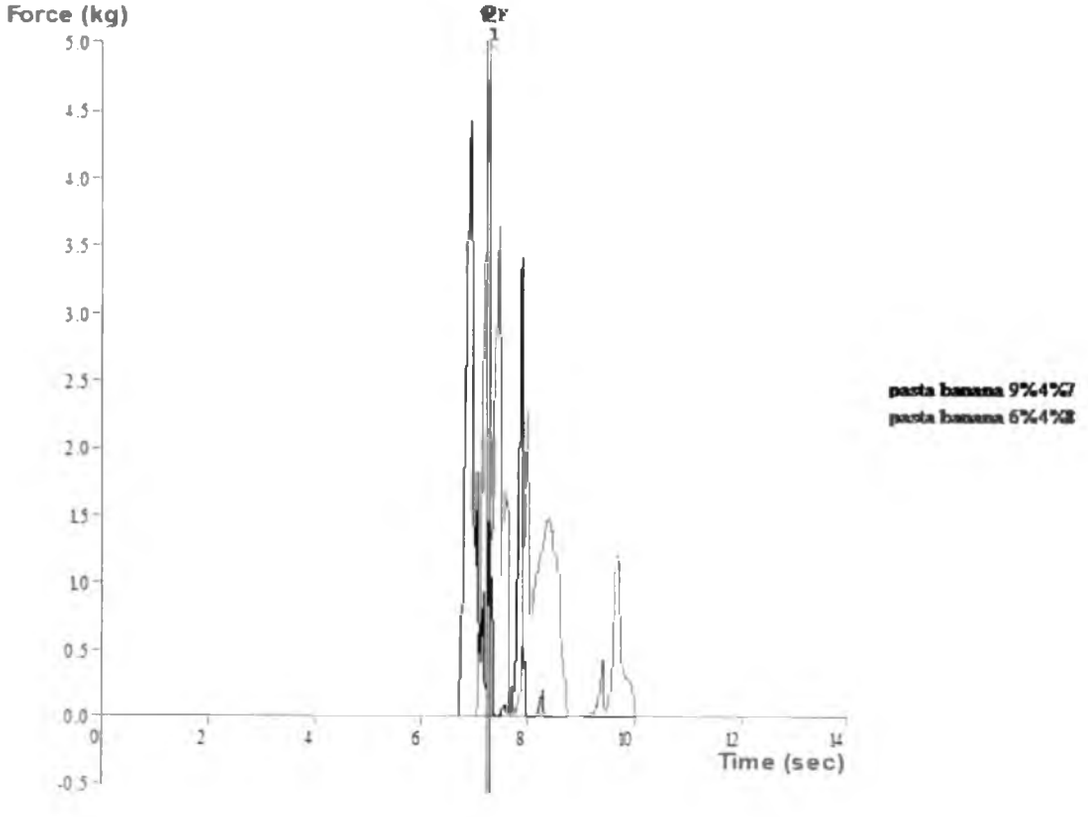


Figure 6.6 Textural characteristics of pasta (6% & 9% banana peel powder)

13. Specific output: Standardized the pre-treatment (blanching) for drying of banana peel

14. Publications and Material Development : **Nil**

15. Infrastructural Facilities Developed : **Nil**

Signature of the Project Investigator :

Co-investigator :

Signature & Comments of the Head of the Department :

Common Projects

Investigation No. 7 RPF II

1. **Project Code** : **PHT/04-01-01-04/TNR (4)/ICAR**

2. **Name of the Institute and Division**

Name and Address of the Institute	:	Kelappaji College of Agricultural Engineering & Technology, Kerala Agricultural University, Tavanur, Malappuram-679 573
Name of The Division/ Section	:	Dept. of Food and Agricultural Process Engineering
Location of the Project	:	KCAET, Tavanur

3. **Project Title** : **Establishment of Agro Processing Centre, training and demonstration of technologies**

4. **Priority Area**

Research Approach	:	04 Technology transfer

5. **Duration of the Project**

Date of Start of the Project	:	2009
Likely Date of Completion of the Project	:	To be continued
Period for which Report Submitted	:	2013-14

6. **Summary of Achievements**

The centre has provided technical guidance to a new agro processing centre, for the production of banana flour. The APC has started its functioning and is in the process of establishing market linkages in the state. The center has been assisting the APC for planning, licensing, packet designing, shelf life studies and quality evaluation of the products and marketing. Another agro processing centre has established at KCAET campus. A coconut oil extraction unit and a roaster and two pulverisers for powdering spice and grains are installed at this APC, to cater to the needs of local people. Testing of the equipments was done and the performance of the machines was found satisfactory. FSSAI registration of the centre has been done for one year. The other APC of this centre at Naduvattom is working satisfactorily.

7. **Key words** : Agro processing

8. **Principal Investigator**

Name	:	**Dr. Santhi Mary Mathew**
Designation	:	Professor
Division/Section	:	Dept of F & APE
Location	:	KCAET, Tavanur

Co-Investigator

1. Name	:	**Dr.Sudheer .K. P.**
Designation	:	Associate Professor
2.Name	:	**Mrs. Sreeja. R**
Designation	:	Assistant Professor
Division/Section	:	Dept of F & APE
Location	:	KCAET, Tavanur

9. Introduction

Farmers often complaint that in spite of increased productivity; their products do not get a remunerative price for a number of reasons such as the presence of middle men, improper marketing system, lack of suitable technologies/equipments etc. On farm and small scale level, value addition of agricultural products is a way out and is one of the challenges that agriculture faces today. Traditional practices associated with the processing of agricultural products are time consuming and involve drudgery. If the farmer could be equipped to add value to their products through the adoption of simple and improved small scale processing equipments and technologies, he could earn profit, thereby being enabled to invest in more productivity. This could also save considerable amount of time and labor and improve the efficiency of processing operations. The process of mechanization for value addition at the farmer's level could also encourage them to utilize the agro by- products thereby control the exodus of the rural people to urban area in search of jobs.

10. Objectives

1) Installation of need based processing equipments at the Agro Processing Centre in view of reducing post harvest losses in the catchment area
2) To organize trainings on the equipments/technology for farming community
3) Run the agro processing centre for commercial production and evaluate its feasibility and adoption
4) To monitor the progress of the centre

11. Technical Programme

1) Monitoring the activities of the existing agro processing units.
2) Assisting the new APC unit for developing market linkages.
3) Conducting training to the farmers and unemployed youths on improved and new technologies.
4) To establish a new agro processing centre at Tavanur

12. Progress in brief

FRIENDS Agro Processing Centre, Naduvattom: The first APC of this centre at Naduvattom is running with two units of areca leaf plate making machine and a hammer mill for spices. The Agro Processing Centre is functioning satisfactorily but the unavailability of areca leaf sheath and lower market value of the plate upsetting the progress of APC at Naduvattom. So the centre should adopt some measures to strengthen the APC by providing other needy gadgets.

Figure 7.1 Products of Friends Agro Processing Centre

Sl. No		Product	Quantity (Kg.)	Income	Expense	Revenue
1	2011-12	Spice powder	357	83,318/-	13,566/-	69,752/-
		Areca leaf plate	5500 Nos.	10,020/-	3,100/-	6,920/-
2	2012-13	Spice powder	289	64,890/-	23,232/-	41,658/-
		Areca leaf plate	3450 Nos.	5,925/-	1,545/-	4,380/-
3	2013-14	Spice powder	566	1,26,283/-	48,420/-	77,863/-
		Areca leaf plate	0	-	-	-
4	Apr 2014 - Nov 2014	Spice powder	426	80,820/-	25,700/-	55,120/-
		Areca leaf plate	0	-	-	-

Table 7.1 Details of the produce processed in Friends Agro Processing Centre

From the above table, it can be observe that the revenue generated in each year has increased remarkably than the previous years except for the year 2012-13.

Model Agro Processing Centre at KCAET campus

The second agro processing centre has been established at KCAET campus. A coconut oil extraction unit and a roaster and two pulverisers for powdering spice and grains are installed in this APC. Testing of the equipments was done and the performance of the machines was found satisfactory. Food Safety and Standards Authority of India registration of the centre has been done and identified the self help group through Tavanur Panchayat for the smooth functioning of the APC.

Suma Foods, Agro Processing Centre at Kulukkallur

The centre has provided technical guidance to a new agro processing centre "Suma Foods" at Kulukkallur (P.O), Palakkad district for the production of Banana flour. Though the APC started with banana flour production, now they are producing ethnic health mix viz., 'Banana- ragi', Banana-Njavara rice mix' and Banana-sugar' mix. The protocols for the production of banana flour and varios health mix was standardized at Tavanur centre. The centre is also giving technical guidance to jackfruit processing plant at Wayand (WASP). The installation of the industry is in progress.

13. Specific output: Technical guidance was given start a new agro processing centre for the production of banana flour. The Friends APC at Naduvattom is running profitably.

14. Publications and Material Development :

1. Vithu P, Sudheer K.P., Pritty S.B, Dhanasree B., Sneha S, Sreeja R. 2014. Optimization of drying process protocol for banana flour preparation, *Proceedings of XXVIIth National Convention of Agricultural Engineers*", on 22nd and 23rd of February, 2014, Thiruvananthapuram, Kerala.
2. Sudheer, K.P. and George.M. 2013. Research Highlights of AICRP on Post Harvest Technology- Tavanur centre, *Research Bulletin No.KAU/PHT/2013/01*, Published by AICRP on Post Harvest Technology, ICAR, & Kerala Agricultural University.
3. Sudheer K.P, Pritty S.B, Vithu P, Dhanasree B., Sneha S. Sreeja R, Prince M.V, and Ranasalva N. 2014. Development of a banana powder based ethnic health mix, *Proceedings of National Conference on "Recent Trends in Processing, Quality and Safety of Ethnic and Organic Foods*" during 26th and 27th June 2014 at Chennai.
4. Sudheer K P, Ranasalva N, Vithu P, Pritty S B, Dhanasree B, and Sneha S. 2015. Development of process protocol and shelf life study of banana flour based ethnic mix, *Paper accepted for presentation in 27th Kerala Science Congress*, to be held at Alappuzha during 27th to 30th January, 2015.

15. Infrastructural Facilities Developed :

Signature of the Project Investigator :

Co-investigator :

Signature & Comments of the Head of the Department :

Investigation No.8

RPF III

1. **Project Code** : **PHT/05-04-01-12/TNR(4)/ICAR**

2. **Name of the Institute and Division**

Name and Address of the Institute	:	Kelappaji College of Agricultural Engineering & Technology, Kerala Agricultural University, Tavanur, Malappuram-679 573
Name of The Division/ Section	:	Dept. of Food and Agricultural Process Engineering
Location of the Project	:	KCAET, Tavanur

3. **Project Title** : **Assessment of Harvest and Post Harvest losses of major crops and commodities in India**

4. **Priority Area**

Research Approach	:	Survey among stakeholders

5. **Duration of the Project**

Date of Start of the Project	:	2013
Likely Date of Completion of the Project	:	Completed
Period for which Report Submitted	:	2013-2014

6. **Summary of Achievements**

As per the direction of the Project Co-ordinator, AICRP on PHT, the centre has taken a project sponsored by the Ministry of Food Processing Industries (MoFPI) on "Assessment of Harvest and Post Harvest Losses of Major Crops and Commodities in India". Accordingly, survey was conducted in Palakkad and Wayanad districts of Kerala. The post harvest losses of commodities viz; rice, tapioca, coconut, black pepper, banana, paddy and arecanut at various levels were estimated and submitted to PC for the estimation of loss at national level.

7. **Key words** :

8. **Principal Investigator**

Name	:	**Dr. Santhi Mary Mathew**
Designation	:	Professor
Division/Section	:	Dept of F & APE
Location	:	KCAET, Tavanur

Co-Investigator

Name	:	**Dr.Sudheer .K. P.**
Designation	:	Associate Professor
Division/Section	:	Dept of F & APE
Location	:	KCAET, Tavanur

9. **Introduction**

Post harvest losses of agricultural commodities are a matter of grave concern for India's agricultural sector. Agricultural commodities produced on the farm fields have to under go a series of operations such as harvesting, threshing, winnowing, bagging, transportation, storage, processing and exchange before they reach the consumer and there are appreciable losses at all stages. All the developed countries used to face this problem. But as the result of continues struggle of the researchers, latest post harvest technologies and storage facilities were emerged, and helped to reduce the losses to a significant level.

But in the case of developing countries like India, these losses are still a crucial problem this may be due to the lack of proper post harvest technologies or knowledge, unawareness of the farmers and unavailability of researchers in the field. In order to overcome this problem a detailed study for the assessment of quality and quantity losses among different crops across the country is required. There for Ministry of Food Processing Industries (MoFPI) instructed ICAR to conduct a survey on "Assessment of Harvest and Post Harvest losses of major crops and commodities in India".

10. Objectives:

1) To assess the Harvest and Post Harvest Losses of Crops/Commodities allotted to this centre.

11. Technical Programme

1) Conducting household's survey, wholesaler's survey, retailer's survey, processor's and storage godown survey in selected villages of two blocks each in Palakkad and Waynad districts.
2) Estimation of Harvest and Post Harvest losses at various levels.
3) Uploading the data collected to ICAR for the estimation of loss at national level.
4) Documentation and report submission

12. Progress in brief

Based on the directions of the ICAR and CIPHET, and as per the conclusions arrived at during the deliberation at various levels, the assessment of Harvest and Post Harvest Losses of crops/ commodities was taken up by this centre. The two districts in Kerala state assigned to this centre were Palakkad and Wayanad and the crops/ commodity allotted were banana, black pepper, coconut, arecanut, cashew nut, tapioca, paddy and marine fish. Since the districts allotted to this centre do not have the sea-shore as well as cashew growers, the survey pertaining to marine fish and cashew nut were not conducted. Wheat was allotted only to the Palakkad district, but there are no wheat growers in the district. Therefore the crops for survey in both the districts are given below.

District	Major crops
Palakkad	Arecanut, Black pepper, Banana, Coconut, Tapioca
Wayanad	Arecanut, Black pepper, Banana, Coconut, Paddy, Tapioca

Table 8.1 details of crops allotted for survey in Palakkad and Wayanad district

The preliminary formality of selecting of the two blocks and five villages from each allotted districts, appointment of field investigators one each for four blocks in the two districts was carried out in August 2005 itself. The complete enumeration work of farmers, wholesalers, retailer, storage godowns and processing units for identified crops/ commodities were then completed. Following this, ten farmers from each village were short listed and out of these two from each village were selected for assessment of harvest and post harvest losses at producer level of the assigned commodities through enquiry and observation respectively. From the enumerated data at market level two each from wholesalers, retailers, storage godowns and processing units were selected respectively for assigned crops from each district for assessment of storage losses at market level. The sampling design and selection procedure adopted during the stages were strictly according to the guidelines and methodology for data collection as approved by AICRP on PHT.

A one day training workshop for field investigators was organized at CPCRI Kasaragode for all the AICRP centres in Kerala (ie, Tavanur, CPCRI and CTCRI). The field investigators attached to all centres in Kerala were given training on how to collect information and fill the data on various assigned crops at different level by enquiry and physical observations methods. The detailed survey schedule by physical observation method for assigned crops were discussed and finalized in order to have uniformity in data collection and case of further analysis.

The survey for the assessment of Harvest and Post Harvest Losses in different channels such as the producer level and market level for coconut, pepper, banana, paddy, arecanut, cashew nut and tapioca during the prescribed unit operations such as harvesting, threshing, cleaning and grading, drying, packaging, transport and storage were carried out at five selected villages in two selected blocks each of Wayanad and Palakkad districts of Kerala. The filled schedules of the previous month were collected from the field investigator at the beginning of the new month and the plan of work for that month was chalked out. Necessary instructions and clarifications were provided to the field investigators and their works were closely monitored through surprise visits and random checking at site to extract reliable information.

Survey was carried out for a period of one year and the data entry has completed as per the directions of the coordinator. The data has already submitted to the PC office for further statistical analysis and for the estimation of post harvest losses at national level.

13. Specific output: The harvest and post harvest losses assessment of the allotted crops of this centre has completed in various levels. The whole work was completed by October 2014 and data collected were submitted to CIPHET Ludhiana for further analysis.

14. Publications and Material Development :

15. Infrastructural Facilities Developed :

Signature of the Project Investigator :

Co-investigator :

Signature & Comments of the Head of the Department :

Investigation No.9 RPF II

1. Project Code : PHT/05-04-02-13/TNR (4)/ICAR

2. Name of the Institute and Division

Name and Address of the Institute : Kelappaji College of Agricultural Engineering & Technology, Kerala Agricultural University, Tavanur, Malappuram-679 573

Name of The Division/ Section : Dept. of Food and Agricultural Process Engineering

Location of the Project : KCAET, Tavanur

3. Project Title : **Study on determining storage losses of food grains in FCI and CWC warehouses and to recommend norms for storage losses in efficient warehouse management**

4. Priority Area

Research Approach :

5. Duration of the Project

Date of Start of the Project : 2013

Likely Date of Completion of the Project : 2016

Period for which Report Submitted : 2013-14

6. Summary of Achievements : Compartment selection and stacks identification completed at two allotted FCI godowns. The process of liquidation with two stacks each was also completed in these allotted godowns.

7. Key words : FCI, liquidation, CWC, losses

8. Principal Investigator

Name : **Dr. Santhi Mary Mathew**

Designation : Professor

Division/Section : Dept of F & APE

Location : KCAET, Tavanur

Co-Investigator

1. Name : **Dr.Sudheer .K. P.**

Designation : Associate Professor

Division/Section : Dept of F & APE

Location : KCAET, Tavanur

9. Introduction

India produced about 250 million tons of food grains in 2011-12 for its 1.23 billion people. Even though the farming and harvesting periods are shorter, the farmers have to wait long time for selling their commodity for a reasonable price. Even after that, the grains are to be stored for a considerable time before reaching in the hands of consumer. For facilitating the grain storage, Government of India established corporations like FCI, CWC, etc. The main objectives of these corporations are to store the grain in good condition without spoil its nutritive value and to prevent physical and economical losses. But notably large amount of stored grain in these facilities are wasted during different operations. An assessment of these losses is required to make a strategy for the problem.

Since the FCI has a significant role in storage and distribution of food grain, the board has approved to undertake a study for the purpose of establishing standards subject to storage losses in the godowns of FCI/CWC/SWC/Private Godowns/Others. The study will take in to account various factors causing storage losses in the godowns such as

1. Environmental factors
2. Operational factors
3. Biotic factors

10. Objectives:

1) To identify the extent of losses commodity wise (wheat, rice, paddy and maize)
2) To identify the factors responsible for losses in storage.
3) To arrive at storage loss norms in different agro-climatic regions/ state with respect to various factors.
4) To suggest ways and means to reduce the extent of storage losses in different unit operation.

11. Technical Programme

1. Training to Field Investigator regarding survey work and data collection.
2. Data collection and quality evaluation of samples
3. Uploading the data collected to ICAR for the estimation of loss at national level.
4. Documentation and report submission.

12. Progress in brief

It was envisaged to identify the extent of storage losses of wheat and rice of selected FCI depot (FSD Angamali & FSD Willingdon Island). One field investigator was appointed on contract basis for the purpose of conducting the survey w.e.f. 02-09-2013. The centre conducted a field visit to FCI godown at Angamali and Willingdon Island and a committee was constituted with 4 members comprising (1) Manager (Depot) (2) Manager(QC) (3) Assistant Grade I(D) and Research Engineer for both Angamali and Willingdon Island depot.

Field investigator is conducting field visits to the selected godowns fortnightly to collect data as per the schedules. Data collection is in progress for the survey schedules. Details about the moisture content, damaged grains, discoloration, chalky grains, broken grains, temperature and relative humidity are collecting fortnightly by the field investigator, regularly.

Lay out of godown , position of stack and selected stack numbers

Table. 9.1 Layout of FSD - ANGAMALI

RAIL SIDE	MG 2 – C-BLOCK			ROAD SIDE
	B10/145 KILLED	C5/116	C9/7 IW(13-14)	
	ALLEWAYS			
	C4/33	C6/8 IW(13-14)	C10/144 IE(13-14)	
	C2/32	C7/9 IW (13-14)	C11/6 KILLED	
	ALLEWAYS			
	C4/139 IW(13-14)	C8/10 IW(13-14)	C12/146 IW(13-14)	

	MG I – B-BLOCK			
ROAD SIDE	B1/08 IW(13-14)	B5/11 IW(13-14)	B3/34	RAIL SIDE
	ALLEWAYS			
	B2/131 IW(13-14)	B6/126	B9/29	
	B3/133 IW (13-14)	B7/10 IW (13-14)	B12/132 IW(13-14)	
	ALLEWAYS			
	B4/09 IW(13-14) KILLED	B8/12 IW(13-14)	A4/135 IW(13-14) KILLED	

Lay out of godown , position of stack and selected stack numbers.

Table. 9.2. Layout of FCI MASONRY (COCHI)

Name of Godown-MSY II

Road Side								
	A6/37	Shutter				Shutter	A2/36	A1/26
	A9/22				A12/30			A14/19
				A18/2				A15/35
	A23/20 KILLED		A24/32	A25/29			A27/4	
Rail Side								

Name of Godown- MSY I

Road Side									
		Shutter	D3/3	D4/6		D6/2	Shutter		D9/18
C1/5								C8/16	
B1/17	B2/31		B3					B8/4	B9/21 KILLED
				A4					
Rail Side									

13. Specific output : Study in progress

14. Publications and Material Development : Nil

15. Infrastructural Facilities Developed : Nil

Signature of the Project Investigator :

Co-investigator :

Signature & Comments of the Head of the Department :

Extension Programmes

Exhibitions/ Demonstrations/ Seminar/ Workshop/training attended & Paper presented

1. Sudheer. K.P. 2014. Paper presented on "Entrepreneurship developments in food processing sector", State workshop "*Niravu Karshika Mela*- 2014" on 30th December at Kannur, Kerala.
2. Sudheer. K.P. 2014. Paper presented in the MSME- Entrepreneurship development programme on "New Developments in Food Packaging", organized by MSME- Development Institute, Ayyanthole (P.O.), on 04-12-2014 at Thrissur.
3. AICRP on PHT participated the technology week (Pulari -2014) organized by KVK Malappuram from 04/01/14 to 09/ 01/14 and in the programme. Various machineries developed by AICRP unit such as white pepper decorticator, pine apple peeler, corer cum slicer, areca nut dehusker etc. were exhibited and demonstrated.

Fig. 10.1. Stall of AICRP on PHT in Pulari 2014 Exhibition at KCAET Tavanur

4. Dr. Sudheer K. P., Associate professor participated in Kerala Science Congress held at Kerala Veterinary and Animal Sciences University, Pookode. Two research papers on Edible wax applicator and preservation of tender jackfruit were presented in the science congress. These works are ongoing research projects under AICRP.
5. Two technologies on Tender jackfruit and HACCP protocol for pepper were selected to present in Technology Innovation Meet held in March 1st, at Kerala Agricultural University.
6. White pepper decorticator developed by the centre has taken to WSS Wayanad for field demonstration and to evaluate the machine and to compare its performance with the machine developed by UAS Bangalore.
7. AICRP on PHT participated in the **Agri-Fiesta Exhibition held from 28th February to 6th March 2014, at KAU Thrissur, Vellanikkara.** Various machineries developed by AICRP unit such as white pepper decorticator, pine apple peeler, corer cum slicer, areca nut dehusker etc. were exhibited and demonstrated.

Fig. 10.2. Stall of AICRP on PHT in **Agri-Fiesta Exhibition at KAU Thrissur**

8. Sudheer. K.P. 2014. Paper presented a paper on "Regulatory practices for domestic and export", in the Global Agro meet and Co- chaired a session on "Export regulations and FSMS" on 7th -8th November, 2014 held at Adlux International Convention centre, Cochin.
9. Sudheer. K.P. 2014. Paper presented in the State level workshop on "Opportunities and Challenges of Women in Agriculture and Allied Sectors" organized by Centre for Gender Studies in Agriculture and Farm Entrepreneurship Development, Kerala Agricultural University, on 21th to 22nd, March, 2014 at Vellanikkara, Thrissur.
10. Sudheer. K. P. 2013. Paper presented on "Pre-cooling and Storage of fruits and vegetables", in the training programme organized by the State Horticulture Mission at, CTI, Thrissur, *on 01- 11 -2013.*
11. Sudheer. K.P. 2013. Paper presented in the State level workshop on "Cultivation and export of aromatic rice's of Kerala" jointly organized by APEDA New Delhi and Kerala Agricultural University, on 21-06-2013 at Mannuthy, Thrissur.
12. Sudheer. K. P. 2013. Participated and paper presented in the National workshop on Codex Alimentarius on 3rd October, 2014 held at Kochi, Kerala.
13. Sudheer. K. P. 2013. Paper presented on "Pre-cooling and Packaging of Horticultural produce", in the training programme organized by the Central training Institute, Kerala Agricultural University, Thrissur, *on 07- 11 -2013.*
14. Sudheer. K. P. 2013 participated and prepared EDP for horticultural processing module at National trade committee meeeting by Ministry of Labour & Employment, New Delhi- on 20-09-2013
15. Sudheer. K.P. 2013. Paper presented in the National Consultation Meeting on Jack fruit on "Development of ready to eat safe tender jack fruit", jointly organized by ICAR and Banana research station, Kannara, on 01-06-2013 at Thrissur, Kerala.

16. Sudheer. K.P. 2013. Paper presented in the MSME- Management development programme on "Food safety management systems in food processing industries", organized by MSME- Development Institute, Thrissur, on 01-03-2013 at Malappuram.
17. Sudheer. K.P. 2013. Participated and presented a paper on "Value addition strategies and policies" at State level workshop on the implications of the Agricultural Development Policy, 27/08/13. at College of Horticulture. Vellanikkara, Thrisssur.
18. Sudheer. K.P. 2013. Participated in the "Entrepreneur interface" organized by Doordarsan and Department of Agriculture at Palakkad, Kerala.

Fig. 10.3. Entrepreneur Interface at Palakkad by Doordarsan

19. Sudheer. K. P., 2014. Paper presented on "Post harvest Technology of horticultural crops- special emphasis on pre-cooling and Packaging of Vegetables", in the training "Protected Cultivation", funded by the State Horticulture Mission and organized by the Central training Institute, Kerala Agricultural University. Thrissur, *on 31- 10 -2014.*
20. Sudheer. K. P. 2014. Paper presented on "Post harvest Technology of fruits, Vegetables and flowers", in the training "Protected Cultivation", Central training Institute, Kerala Agricultural University, Thrissur, *on 27- 11 -2013.*
21. Sudheer. K.P. 2014. Visited IICPT Tanjavur with potential entrepreneurs for the demonstration of RTE extruded products using twin screw extruder on 28-09-2014.
22. Sudheer. K.P. delivered an invited lecture on "Recent developments in food processing sector" on World food day at SAFI Institute of Advanced Study on 22/10/13.
23 AICRP on PHT participated in the "Food- Pro meet" held from 28th February to 6th March 2013, at Cochin. Various machineries developed by AICRP unit such as white pepper decorticator, areca nut dehusker, Banana slicer, etc. were exhibited and demonstrated.
24 Sudheer. K.P. 2014. delivered an invited lecture on "Post Harvest Handling and Storage in Organic Farming and Importance of Organic Certification " at CTI Kerala Agricultural University, Vellanikkara on 15-10-2014.

Stall of AICRP on PHT in Food- Pro Meet **Exhibition at Cochin**

Publications of AICRP staff during the reporting period

1. Sudeer K.P, Preenu, N.P. and Singh R.K. .2014. Effect of drying methods on colour and hydroxy citric acid content of *Garcinia Cambogia*.". In: Proceedings of the National Seminar on Family Farming: Agroforestry options for food, nutritional and ecological security in humid tropics to be organised by College of Forestry Vellanikkara Thrissur, at College of Forestry, Vellanikkara, Thrissur, Kerala during December 21st -23rd, 2014. ***(Received the best poster award)***
2. Sudheer K.P. and Rana S.N. 2014. Mechanization of Food Industry in India, *Proceedings of the State level workshop on "Opportunities and Challenges of Women in Agriculture and Allied Sectors"*, Centre for Gender Studies in Agriculture and Farm Entrepreneurship Development, Kerala Agricultural University, on 21th to 22nd, March, 2014 at Vellanikkara, Thrissur.
3. Joy A K, Sudheer. K.P., Athira A.S., Cinu V, Haritha M., and Rana Salva N. .2015. Development and performance evaluation of a motorised rotary banana slicer".- *Paper accepted for presentation* in 27th Kerala Science Congress, to be held at Alappuzha during 27th to 30th January, 2015.
4. Sudheer K P, Rana S.N, Vithu P, Pritty S B, Dhanasree B, and Sneha S. 2015. Development of process protocol and shelf life study of banana flour based ethnic mix, *Paper accepted for presentation* in 27th Kerala Science Congress, to be held at Alappuzha during 27th to 30th January, 2015.
5. Sudheer K P, Nithya C, Sunena T P, Drishya M, Steffy J, Rana Salva N, and Prince M V. 2014. Standardization of process protocol for the production of pseudostem- ginger powder, In: *Proceedings of ICFOST- 2014* during 13th to 14th November 2014, at NIFTEM, Kundli.
6. Athira S, Rooshi M K, Alfiya P V, Sudheer K P, Rana Salva N, and Sreeja R. .2014. Optimization of process parameters for micro-encapsulated whey melon by spray drying, In: *Proceedings of ICFOST-2014* during 13th to 14th November 2014, at NIFTEM, Kundli.

7. Sudheer K.P, Pritty S.B, Vithu P, Dhanasree B., Sneha S. Sreeja R, Prince M.V, and Ranasalva N .2014. Development of a banana powder based ethnic health mix, In: *Proceedings of National Conference on Recent Trends in Processing, Quality and Safety of Ethnic and Organic Foods*" during 26th and 27th June 2014 at Chennai.
8. Griet K, Sudheer K. P, Ines C, Sandy V.B., Marc H., and Ann V.L. 2013. Isomerisation of carrot ß-carotene in presence of oil during thermal and combined thermal/high pressure processing, *Food Chemistry*, Vol 138, Issues 2-3, Pages 1515- 1520.
9. Sudheer. K.P., Griet K., and Marc H. 2013. Quality changes in high pressure processed tomato puree, In: *Proceedings of International conference on food technology: Ncoftech edition III*, January 4th to 5th 2013, at Indian Institute of Crop Processing & Technology, Thanjavur.
10. Sudheer. K. P. and Pretty S. B. 2013. High pressure processing of vegetables, in the compendium of National training on "Application of high pressure for food processing", organized by Central institute of fisheries technology, Cochin-682 029: pp: 31-44.
11. Aneeshya K.K.S, K. P. Sudheer, and T. J. Sheriff. 2013. Textural properties and economic feasibility of an extruded RTE snack from starch based food products. In: Proceedings of XXVth Kerala Science Congress, 29th January to 1st February, 2013, held at Technopark, Thiruvananthapuram, Kerala, India.***(Received the best post award)***
12. Pritty. S. B, and Sudheer K. P. 2014. Thermal process optimization for tender Jackfruit *(Artocarpus Heterophyllus L.). In: Proceedings of XXVIth Kerala Science Congress,* 28th to 31st January, 2014, held at Kerala Veterinary & Animal sciences University, Pookod, Wayanad, Kerala, India.
13. Sudheer. K. P. 2013. Effect of high pressure processing on quality of vegetables, in manual on Application of high pressure and Pulsed light technology for food processing", National training on Non thermal and non chemical technologies - organized by Central institute of fisheries technology, Cochin-682 029: pp: 40-58.
14. Madhana S.R. and Sudheer K. P.. 2014. Effect of edible coating on the quality parameters of passion fruit (Passiflora edulis) In: *Proceedings of of XXVIth Kerala Science Congress*, 28th to 31st January, 2014, held at Kerala Veterinary & Animal sciences University, Pookod, Wayanad, Kerala, India.
15. Sudheer K.P., Supriya M.R., Hima J, Alfiya P.V., and Chinchu M. 2014. Effect of edible coating and modified atmospheric packaging on shelf life of fruits and vegetables, *In: Proceedings of XXVIIth National Convention of Agricultural Engineers* on 22nd and 23rd February, 2014, Thiruvananthapuram, Kerala.
16. Sunitha C.P. and Santhi M.M. 2014. Standardization of process protocol for the production of *Garcinia Cambogia* powder. *Proceedings of ICFOST-* 2014 during 13th to 14th November 2014, at NIFTEM, Kundli.
17. Vithu P, Sudheer K.P., Pritty S.B, Dhanasree B., Sneha S, and Sreeja R. 2014. Optimization of drying process protocol for banana flour preparation, *Proceedings of XXVIIth National Convention of Agricultural Engineers* on 22nd and 23rd of February, 2014, Thiruvananthapuram, Kerala.
18. Hima J, Sudheer K.P. and Chinchu M. 2014. Shelf-life studies of modified atmosphere packed slicing cucumber (*Cucumis sativus*), *Proceedings of XXVIIth National Convention of Agricultural Engineers* on 22nd and 23rd of February, 2014, Thiruvananthapuram, Kerala.

Appendices

Financial information

Staff position at KCAET Tavanur Centre

Appendix. I. a. Financial Information:

Expenditure statement from 01/04/10 to 31/03/12

Sl. No	Year	Sanctioned grant (Rs.)			Expenditure (Rs.)	Expenditure as % of sanctioned grant
		ICAR share	University share	Total		
XII-FIVE YEAR PLAN						
1.	2012-2013	Rs.17,33,000/-	Rs.5,77,667/-	Rs.23,10,66/-	Rs.33,23,924/-	143.85
2.	2013-2014	Rs.36,95,000/-	Rs.12,31,667/-	Rs.49,26,667/-	Rs.39,89,684/-	80.98
3.	Apr 2014-Dec 27th 2014	Rs.27,50,000/-	Rs.9,17,000/-	Rs.36,67,000/-	Rs.33,70,613/-	91.90

Appendix- I. b. Expenditure Statement from 2012 to 2013

Sl. No.	Budget Head	Sanctioned grant	ICAR share	University share	Total expenditure
2012-2013					
1	Pay and Allowance	Rs.20,00,000/-	Rs.15,00,000/-	Rs.5,00,000/-	Rs. 30,54,429/-
2	Traveling allowance	Rs.64,000/-	Rs.48,000/-	Rs.16,000/-	Rs. 66,804/-
3	Contingencies a. Recurring b. HRD	 Rs.2,13,333/- Rs.33,333/-	 Rs.1,60,000/- Rs.25,000/-	 Rs.53,333/- Rs.8,333/-	 Rs. 177573/- Rs.25118/-
	Total	**Rs.23,10,667/-**	**Rs.17,33,000/-**	**Rs.5,77,666/-**	**Rs.33,23,924/-**

Appendix I.c. - Expenditure Statement from 2013 to 2014

Sl. No	Budget Head	Sanctioned grant	ICAR share	University share	Total expenditure
2013-2014					
4.	Pay and Allowance	Rs.46,46,667/-	Rs.34,85,000/-	Rs.11,61,667/-	Rs.36,69,091/-
5.	Traveling allowance	Rs. 93,333/-	Rs. 70,000/-	Rs.23,333/-	Rs.79,721/-
6	Contingencies a.Recurring	Rs.1,86,667/-	Rs. 14,000/-	Rs. 46,667/-	Rs.2,40,872/-
	Total	**Rs. 49,26,667/-**	**Rs.36,95,000/-**	**Rs. 12,31,667/-**	**Rs.39,89,684/-**

Appendix- II: Staff Position as on 31-12-2014

Sl. No.	Name of the post	Name of incumbent	Date of appointment	Date of Relieve	Post		
					Sanctioned	Filled	Vacant
1.	Research Engineer (Rs.37,400-67,000)	Dr. Santhi Mary Mathew	01-07-2013	Continuing	1	1	-
2.	Assistant Research Engineer (Rs.15,600-39,100)	Dr. Sudheer. K.P.	15-08-2011	Continuing	1	1	-
3.	Assistant Professor (Bio chemistry) (Rs.15,600-39,100)	Ms. Sreeja. R	05-06-2013	Continuing	1	1	-
4.	Technician, Grade T-II-3 (Rs.13,230-22,360)	Er. Deepak. P. H Er. Reshma. M	02-09-2013 07-04-2014	03-04-2014 Continuing (Contract basis)	1	1	-
5.	Lab Technician T-I (Rs.10,480-18,300)	Mr. Ashraf A. Mr. Lenin.M.K Mr. Manohar Krishna	3-12-2005 22-05-2014 3-12-2005	17-05-2014 Continuing Continuing (Contract basis)	2	2	-
6.	Technician T-I (Lab tech./ Data Entry Operator) (Rs.10,480-18,300)	Mrs. Jojitha.K.C	01-02-2012	Continuing (Contract basis)	1	1	-
7.	Junior Clerk (Rs.13,900-24,040)	-	-	-	1	0	1
8.	**Total**				**8**	7	1