



MAURITIUS RESEARCH COUNCIL
INNOVATION FOR TECHNOLOGY

PROCESSING OF PALM SHOOTS

Final Report

September 2001

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UNIVERSITY OF MAURITIUS

FACULTY OF AGRICULTURE

PROCESSING OF PALM SHOOT

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Research Team

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PROCESSING OF PALM SHOOTS (CONTRACT NO. 98/3)

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1. OBJECTIVES OF THE PROJECT

The primary objective of the project was to develop value-added, shelf-stable processed products of palm shoot *Dictyosperma album* in view of their production in a local processing plant.

The study had been designed in three stages, each with defined objectives.

1.1 STAGE ONE: CHARACTERISATION OF THE PHYSICAL, CHEMICAL AND SENSORY PROPERTIES OF PALM SHOOT

This first stage of the project aimed at evaluating the physical, chemical and sensory characteristics of palm shoot *Dictyosperma album* grown locally. This included evaluation of the colour, texture and taste, physical measurements, quantification of the edible/non-edible ratio, determination of pH, Brix, titratable acidity, moisture content, ash content, ascorbic acid, crude fibre and crude protein, and inhibition of browning reactions.

1.2 STAGE TWO: PRODUCT DEVELOPMENT AND SHELF LIFE STUDIES

The main objective of this stage was initially to develop pickled and canned products from palm shoot. However, canning was, at later stage, rejected. This decision was taken by members of the research team, the Groupement Palmiste, and the Mauritius Chamber of Agriculture after considering the low volume of imports of canned palm shoot, its limited market and its high projected unit cost price.

Pickling was therefore the method retained for product development. This involved formulation trials, sensory evaluation, microbiological analysis and physicochemical

analysis. Furthermore, shelf life testing was also carried out to assess the keeping quality of the products both in terms of their safety and organoleptic quality.

1.3 STAGE THREE: ACCEPTABILITY OF PRODUCTS AND PROCESSING LINE

The final stage of the project aimed at assessing the acceptability of the new product by conducting a consumer-oriented sensory evaluation survey. The production requirements in terms of processing steps and quality control would also be finalised.

2. METHODOLOGY

2.1 STAGE ONE: CHARACTERISATION OF PHYSICAL AND CHEMICAL PROPERTIES OF PALM SHOOT

Palm shoots are graded according to the shoot circumference as follows:

Grade A: > 45 cm

Grade B: 35 - 45 cm

Grade C: 25 - 35 cm

Grade D: < 25 cm

Remarks: It was noted that it was difficult in practice to clearly distinguish between Grade C and Grade D. It was henceforth decided that experiments would be carried out on Grades A, B and C only.

Each grade was divided into two classes:

- (i) Edible portion (Bud and leaf covering bud)
- (ii) Non-edible portion

2.1.1 Statistical design and analysis

A Completely Randomised Design was used to test whether there were significant differences in the physical and chemical properties between the three palm shoot grades. Six replicates were used for the physical determinations and five for the chemical determinations. Further, duplicate measurements were made for each determination to ensure accurate results. The choice of at least five replicates ensured at least 12 degrees of freedom (df) for the error which is the usual recommended df for a precise estimate of the error variance necessary for all the statistical tests.

Results were analysed using one-way ANOVA and mean comparisons were carried out using the Least Significant Difference (LSD).

2.1.2 Determination of organoleptic properties

Freshly harvested palm shoots were used for this study. Three replicates per grade were used. The following characteristics of the edible portion were assessed:

- i. Texture (residue upon mastication was used to assess edibility)

- ii. Colour of edible portion was visually evaluated
- iii. Taste

2.1.3 Determination of physical properties

2.1.3.1 Length, circumference and weight

Physical measurements were taken on the unsheathed bud and these included:

- i. Length, measured with a measuring tape
- ii. Circumference, measured with a measuring tape
- iii. Weight, measured on a weighing scale

2.1.3.2 Edible/Inedible weight ratio

Leaf sheaths were removed and the weight of the edible portion was recorded. The ratio of edible/non edible was then calculated.

2.1.4 Determination of chemical properties

This study was carried out on three grades (A, B, C), using five replicates per grade.

2.1.4.1 pH

pH of fresh shoot sample was measured with a calibrated pH meter, in duplicate. The sample was previously blended and filtered through absorbent cotton, the filtrate being used for the measurement.

2.1.4.2 Brix

Total soluble solids (Brix) of fresh palm shoot were determined by a hand refractometer according to Askar *et al.* (1993). The sample was first blended and filtered through absorbent cotton. 2 to 3 drops of the filtrate were used for the measurement. Temperature and citric acid corrections were applied to get the true Brix value at 20°C.

2.1.4.3 Titratable acidity

This was determined by potentiometric titration of the fresh sample against a standard sodium hydroxide solution. Fresh palm shoot was previously blended with hot water, boiled, cooled and diluted to volume with distilled water.

2.1.4.4 Moisture content

This was determined by accurately weighing about 5 g of fresh sample in a previously dried and tarred aluminium dish. The latter was then placed in an oven and dried to constant weight at 105° C. The sample was then left to cool at room temperature in a dessicator and weighed. The difference in weight was used to calculate the moisture content as follows:

$$\% \text{ Moisture content (wet basis)} = [\text{Moisture content (g)}/\text{Fresh weight}] \times 100$$

2.1.4.5 Ash content

Total ash was determined by weighing the inorganic residue after the organic matter has been burnt away.

About 2 g of sample were accurately weighed in previously preheated, cooled and tared crucibles. The latter were then placed in a furnace where the temperature was increased to 300°C. After 2 hours, the temperature was increased to 500°C and the samples were allowed to ash for 3 hours. The samples were then left to cool in a dessicator after which they were weighed. The ash content was calculated as follows:

$$\% \text{ Ash (wet basis)} = (\text{weight of ashed sample}/\text{weight of fresh sample}) \times 100$$

2.1.4.6 Ascorbic acid

The ascorbic acid content was determined by macerating the sample with metaphosphoric acid-acetic acid solution and titrating the filtered extract with 2,6-dichlorophenolindophenol, according to AOAC Official method 967.21 (1995).

2.1.4.7 Crude fibre

Crude fibre content was determined according to AOAC standards using a TECATOR Fibertec unit.

2.1.4.8 Protein content

The protein content on a dry basis was determined by the Kjeldahl method using an automated Kjeltec system. The conversion factor used was 6.25.

2.1.4.9 Inhibition of browning/blanching tests

2.1.4.9.1 Enzymatic browning in palm shoots

The main objective of this experiment was to observe browning reaction in palm shoot and to estimate the speed with which browning occurred. This study was carried out on three replicates of grade A, B, and C. Browning reaction was observed on three forms of palm shoots, namely:

Whole

1. Sliced

2. Shredded

Palm shoots were exposed to air and the time taken for browning to occur was noted.

2.1.4.9.2 Browning inhibition

This study was carried out on three grades of palm shoots on two replicates whereby each palm shoot was divided into two equal parts.

2.1.4.9.2.1 Blanching tests

The major objective of this experiment was to determine the time required for adequate blanching to occur. Shoots were dipped, at three time intervals, in hot boiling water and a peroxidase test was used to test for the adequacy of blanching.

2.1.4.9.2.2 Water treatment

The time taken for palm shoots to brown in water at room temperature was noted.

2.1.4.9.2.3 Ascorbic acid treatment

The main objective of this experiment was to study the effect of ascorbic acid on browning of palm shoots. Three concentrations of ascorbic acid were used namely 0.2 %, 0.5 %, 1 % and the time taken for browning to occur was noted.

2.2 STAGE TWO: PRODUCT DEVELOPMENT (PICKLING) AND SHELF LIFE STUDIES

2.2.1 Product development: Pickle

2.2.1.1 Pickle formulations

The initial formulation was developed from pickles' recipes that exist in the local market, i.e. commercial and home recipes. A total of 9 different product formulations were developed. Each formulation was tested in-house and slight modifications were brought about either in composition or sample preparation. Table 1 summarises the steps in palm shoot preparation. Table 2 summarises the composition of the different formulations. Based on several in-house tests of the different formulations, formulations 7, 8 and 9 were retained for further sensory analysis by selected trained panellists. Only formulation 9 was chosen for an in-house preference test to assess its acceptability compared to a reference.

2.2.1.2 Preparation of palm shoot

The different methods of preparing the palm shoot are given in Table 2.1.

Table 2.1: Modifications in palm shoot preparation

Formulation 1	Formulation 2	Formulation 3	Formulation 4
• Surface treatment with ascorbic acid (1.5 % w/v)			
• Blanching of whole shoot in boiling water (4 min)	• Blanching of whole shoot in brine (5% w/v - 4 min)	• Blanching of whole shoot in boiling water (5 min)	• Blanching of whole shoot in brine (5% w/v - 4 min)
	• Cooling in water	• Cooling in ascorbic acid solution (1.5 % w/v - 5 min).	• Cooling in cold vinegar
• Slicing of shoot along its length (3-5 mm long).	• Slicing of shoot along its length (1 cm long).	• Slicing of shoot along its length (3-5 mm long).	• Slicing of shoot along its length (1 cm long).
• Soaking in ascorbic acid solution (1.5 % w/v).			• Soaking in vinegar overnight in the refrigerator
	• Drying in the sun (2-3 h).		• Draining and drying in kitchen towel
			• Drying in air - 2 h
• Draining and mixing with other ingredients.	• Mixing with other ingredients.	• Mixing with other ingredients	• Mixing with other ingredients.

Table 2.1 (contd.)

Formulation 5	Formulation 6	Formulation 7	Formulation 8	Formulation 9
• Surface treatment with ascorbic acid (1.5 % w/v).	• Surface treatment with ascorbic acid (1.5 % w/v).	• Surface treatment with ascorbic acid (1.5 % w/v).	• Surface treatment with ascorbic acid (1.5 % w/v).	• Surface treatment with ascorbic acid (1.5 % w/v).
• Blanching of whole shoot in boiling water (5 min)	• Blanching of whole shoot in boiling water (5 min)	• Blanching of whole shoot in boiling water (5 min)	• Blanching of whole shoot in boiling water (5 min)	• Blanching of whole shoot in boiling water (5 min)
• Cooling in ascorbic acid solution (1.5% w/v - 5 min).	• Cooling in ascorbic acid solution (1.5% w/v - 5 min).			
• Slicing of shoot along its length (3-5 mm long).	• Slicing of shoot along its length (3-5 mm long).	• Slicing of shoot along its length (5-7 mm long).	• Slicing of shoot along its length (5-7 mm long).	• Slicing of shoot along its length (5-7 mm long).

• Mixing with other ingredients.	• Mixing with other ingredients.	• Cooling in sodium metabisulphite solution (0.25% w/v - 5 min). • Draining and mixing with other ingredients.	• Cooling in sodium metabisulphite solution (0.25% w/v - 5 min). • Draining and mixing with other ingredients.	• Cooling in sodium metabisulphite solution (0.25% w/v - 5 min). • Draining and mixing with other ingredients.
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Table 2.2: Composition of palm shoot pickles

Composition (% ^w / _w)									
Formulation	1	2	3	4	5	6	7	8	9
Ingredient									
Palmshoot	72.00	71.85	70.00	66.00	63.00	60.50	69.44	68.94	68.94
Garlic	0.37	0.75	0.40	1.00	1.00	1.00	0.75	0.75	0.75
Turmeric	1.29	1.50	2.00	2.00	2.00	2.00	1.70	1.70	1.70
Mustard seeds	1.00	2.00	1.50	2.50	3.00	3.00	1.50	1.50	1.50
Salt	1.44	1.50	1.75	1.90	2.00	2.00	1.75	1.75	1.75
Vinegar	2.17	-	2.50	-	-	-	2.00	-	-
Citric acid	0.36	-	0.40	-	-	-	0.36	0.36	0.36
Oil	10.86	20.00	20.00	25.00	25.00	25.00	20.00	20.00	20.00
Water	9.00	-	-	-	-	-	-	-	-
Ginger	-	0.20	-	0.20	-	-	-	-	-
Methi seeds	-	0.20	0.45	0.40	0.50	0.50	1.5	1.5	1.5
Chilli	1.44	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lemon juice	-	-	-	-	2.50	-	-	2.50	-
Tamarind	-	-	-	-	-	5.00	-	-	10.00
pH	3.88	-	3.65	3.87	4.41	4.37	3.56	3.50	3.56

2.2.1.3 Preparation of spices

Where fresh garlic and ginger were used, they were blanched in hot boiling water for 2 minutes, peeled and then crushed (Kenwood Major) with water to form a paste. In most of the formulations, garlic powder, mustard powder and red chilli powder were bought from the local supermarket. Methi seeds were first slightly roasted and then ground into a powder.

2.2.1.4 Preparation of the pickles

Table 2.2 shows the modifications in composition of the nine different formulations.

Sliced palm shoot was weighed and the amount of the spices to be added was calculated from the formulation.

The palm shoots and ingredients were mixed in a clean bowl, then filled in dry jars, which had been previously washed in boiling water.

pH of the pickle was measured to determine the thermal treatment, i.e., pasteurisation or sterilisation conditions. pH being below 4.50 for all formulations, the pickle was pasteurised in boiling water for 10 minutes, the time taken for the temperature at the thermal centre of the jar to reach 80°C.

2.2.1.5 Sensory evaluation of palm shoot pickles

2.2.1.5.1 Briefing and selection of potential panelists

- 28 potential panelists were identified: 26 second-year students on the Diploma/B.Sc. course in Food Science and 2 members of the administrative staff of the Faculty.
- Potential panellists were briefed on the nature and objectives of the research project.
- Questionnaires (Annex 1) were distributed to potential panellists to collect information on the following aspects: history of potential panellists, exposure to pickle products, interest and availability to participate in the project.
- Based on information given in the questionnaires, all potential panellists were selected for the screening tests.

2.2.1.5.2 Screening of potential panellists

- Panellists were screened for sensory acuity, descriptive ability, discriminative ability and sensitivity using the following tests: taste and odour recognition tests, triangle tests and threshold tests (Annex 2).
- Out of the 28 potential panellists, 18 panellists were selected based on their performance in the screening tests.

2.2.1.5.3 Determination of the sensory profiles of three palm shoot pickle formulations and a commercial product

2.2.1.5.3.1 Development of vocabulary

One selected panellist was not present for the profiling sessions. Each of the 17 panellists described the colour, odour, texture, taste and after-taste of the three palm shoot pickle formulations in his/her own terms (Annex 3). Then the whole panel and the panel leader discussed all the terms identified by the individual panellists in order to obtain a consensus of attribute terms which all panellists agreed could be detected in the samples.

2.2.1.5.3.2 Quantitative assessment of attributes

Each panelist evaluated the three palm shoot pickle formulations and the commercial product. All attributes, except colour, were scored for intensity using a line scale. Colour was assessed using a descriptive scale (Annex 4). Two replicate sessions were carried out and the four samples were evaluated during each session. The samples were assessed one at a time and the order of presentation was randomised, i.e., each panellist received the samples in a different order.

2.2.1.5.3.4 Statistical Design and Analysis

A Randomised Block Design was used for the sensory experiment. Panellists, being a known source of variation, were used as blocks. The treatments were the four formulations, namely products A, B, C & D. For analysis, the categories were converted to numerical scores and subjected to a two-way Analysis of Variance. Mean comparisons of the different sensory characteristics for the different pickle formulations were carried out using the Least Significant Difference (LSD).

2.2.1.5.4 Preference tests

A paired preference test was used by an in-house consumer panel to determine the preference of the commercial product (Formulation 1, D) to the trial sample (Formulation 9, C).

Fifty-two untrained panellists recruited from the Faculty of Agriculture were presented with the two samples simultaneously and requested to choose which one of the two coded samples they preferred (Annex 5).

2.2.1.6 Microbiological analysis

Preliminary microbiological analysis was carried out on formulation 9 to evaluate the adequacy of the pasteurisation treatment and the hygienic quality of the pickle. Furthermore, the evolution of the microbial flora in the pickle stored in different conditions was monitored over a one-month period. 200-g jars of pickles were kept at room temperature, at 4°C (domestic refrigerator temperature) and at 4°C after opening. 2 samples from each lot were taken at seven-day interval for analysis over the one-month period.

2.2.1.6.1 Sample preparation

25 g of sample was weighed accurately into a sterile stomacher bag. 225 ml of sterile diluent (peptone water 0.1 %) were added. The mixture was macerated for 2 minutes at medium speed using the Stomacher Seward 400 to obtain the mother sample.

2.2.1.6.2 Dilutions

Serial dilutions of the mother sample were prepared using sterile 0.1 % peptone water as diluent.

2.2.1.6.3 Total Viable Count

Plate Count Agar medium was used to enumerate the total microbial flora of the samples, in duplicate, using the pour plate method. Observations were made after incubation at 30°C for 72 hours of the inoculated plates. Only plates that had between 30 and 300 colony-forming units (CFUs) were counted.

2.2.1.6.4 Coliform

Brilliant Green Lactose Bile Broth was used to estimate the Most Probable Number (MPN) of coliforms in the samples. Tests were done in duplicate for each sample. Observations were made after incubation at 37°C for 24 hours of the inoculated tubes. Presumptive positive tubes, i.e. those showing growth and gas production, were recorded. The MPN of coliforms was determined from Mac Grady's table.

2.2.1.6.5 Sulphite Reducing Anaerobes (Clostridia)

Meat Liver Agar medium was used to enumerate the sulphite-reducing anaerobic microorganisms, which include clostridia, in the samples. Tests were done in duplicate for each sample. Number of distinct, black colonies was counted after incubation at 37°C for 24 hours of the inoculated tubes.

2.2.1.6.6 Staphylococcus

Baird Parker Agar medium was used for this enumeration. Surface inoculation was performed. Tests were done in duplicate for each sample. Incubation of the inoculated plates was done at 37°C for 24 hours (or 48 hours if no colonies developed).

Colonies that were 1.0-1.5 mm in diameter, black, shiny, convex with a narrow white entire margin and surrounded by a clear zone extending 2-5 mm into the opaque medium were counted. Confirmation of staphylococcus was done by viewing under the microscope after Gram staining.

2.2.1.6.7 Calculations

For each solid-media test, mean number of colony-forming units (CFUs) per g of pickle was calculated from selected dilutions.

2.2.1.7 Physicochemical analysis

2.2.1.7.1 pH

pH was measured at room temperature using a calibrated pHmeter.

2.2.1.7.2 Water activity

5-g samples were weighed in aluminium dishes and placed in desiccators of constant water activity. They were kept at constant temperature of 25°C until constant weight of samples was recorded. Constant water activity atmospheres were established using saturated salt solutions. Water activity of samples was deduced from a graph of weight change against water activity, i.e. at the point corresponding to no weight change.

2.2.2 Shelf-life studies

One pickle formulation was chosen out of nine formulations for shelf life studies. The selection was essentially based on sensory analysis by trained taste panellists. Shelf life studies involved sensory, microbiological and physicochemical analyses.

Following preliminary microbiological and shelf life studies, the method of processing, in particular the pasteurisation conditions, was also reviewed. The heat treatment was increased 15 minutes to further reduce the microbial load, and therefore to improve the safety and keeping quality of the pickle.

2.2.2.1 Preparation of samples

One hundred and thirty 212-ml jars of pickle were prepared according to set processing steps. This involved peeling of shoot, chemical treatment, blanching, pickle preparation, filling, pasteurisation, cooling and drying.

The jars were then divided into three lots as follows:

- Lot 1: unopened jars were stored at room temperature for a total period of 12 months
- Lot 2: unopened jars were stored at refrigerated temperature, i.e 4°C for a total period of 12 months

- Lot 3: jars were opened, contents mixed with a spoon and closed. They were then kept at 4°C (this simulated domestic use) for a total period of 1 month.

Samples from each lot were then taken for analysis at monthly intervals for lots 1 & 2, and weekly intervals for lot 3.

2.2.2.2 Sensory evaluation of palm shoot pickles

Samples from each of the 3 lots were presented to trained taste panellists for assessment of their quality attributes via a questionnaire (Annex 6).

2.2.2.3 Microbiological analysis

Samples from the 3 lots were analysed for total viable count, coliforms, sulphite-reducing anaerobes and staphylococcus following procedures described in Section 2.2.1.6.

2.2.2.4 Physicochemical analysis

Samples from the 3 lots were analysed for pH and water activity as per procedure described in Section 2.2.1.7

2.3 STAGE THREE: ACCEPTABILITY OF PICKLE & PROCESSING LINE

2.3.1 Acceptability of pickle

A consumer-oriented sensory evaluation was conducted to determine the acceptability of the new product. A quota sample of roughly three hundred (300) people was targeted for the study, which is of the order usually suitable for such type of studies (Watts et al, 1989)(The actual sample size was 302).

During discussions investigators felt that ethnic group might be a key factor in the acceptability of the new product. So, since comparison between ethnic groups was of interest, roughly equal quotas, ($N \approx 100$ per group) representing the three main ethnic categories (Non-Chinese Asians, Chinese, General population) in Mauritius were sampled.

Gender and location were also of interest but no information is available as per their distribution in the three different ethnic categories above. Thus respondents in each ethnic category were subdivided equally as shown below to reflect closely the population profile. The sample design was thus adopted after careful consideration of precision, practicability and information available.

The final sample allocation is shown in Table 2.3 below.

Table 2.3. Sample characteristics for consumer-oriented sensory evaluation

Ethnic Group	Gender	Region	
		Rural	Urban
Chinese	Male	20	27
	Female	19	31
Non-Chinese Asian	Male	24	21
	Female	28	28
General population	Male	25	26
	Female	24	29

The sensory evaluation questionnaire (Annex 7) was developed and it was pretested on 10 consumers before the full-study was launched. Data Analysis was performed using the statistical software SPSS®.

2.3.2 Processing line

The process steps were finalised with respect to process conditions and quality control tests.

3 RESULTS & DISCUSSION

3.1 STAGE ONE: CHARACTERISATION OF PHYSICAL, CHEMICAL AND SENSORY PROPERTIES OF PALM SHOOT

3.1.1 Organoleptic properties (Texture/Colour/Taste) of three palm shoot grades

For all three grades A, B and C, shoots were crisp, non-fibrous, brittle and could be easily separated. They were cream coloured with a greenish tinge and had a bland taste.

3.1.2 Physical properties of three palm shoot grades

The physical properties of three grades of palm shoot, namely A, B, and C are shown in Table 3.1 below. Weight, circumference and number of outer leaves were significantly greater ($p < 0.5$) for grade A shoots. This was expected since Grade A shoots are in fact larger in size than the other grades.

Table 3.1: Physical properties of palm shoot

Physical Properties ¹	GRADE A	GRADE B	GRADE C
LENGTH OF SHOOT (cm)	110 ± 3.7	114 ± 7.3	102 ± 7.6
WEIGHT OF SHOOT (kg)*	21.6 ± 1.21	17.8 ± 0.62	11.4 ± 0.86
WEIGHT OF EDIBLE PORTION (kg)*	2.1 ± 0.33	1.4 ± 0.09	1.3 ± 0.09
% WEIGHT RATIO EDIBLE: NON-EDIBLE	10.2 ± 1.59	8.1 ± 0.66	11.8 ± 1.02
LENGTH OF EDIBLE PORTION (cm)	47.9 ± 2.88	42.8 ± 1.38	44.3 ± 1.91
NUMBER OF LEAVES*	9.8 ± 0.40	8.7 ± 0.42	8.0 ²
CIRCUMFERENCE (cm)*	55.3 ± 1.50	43.9 ± 1.29	36.6 ± 0.37

± : S.E

¹ Means are based on six replicates

² All shoots had 8 leaves

* Means for the three grades are significantly different at $p < 0.05$

3.1.3 Chemical properties of three palm shoot grades

The chemical properties of three grades of palm shoot, namely A, B, and C are shown in Table 3.2. Palm shoot did not show grade wise differences with respect

to pH, titratable acidity, ash content, ascorbic acid content, crude fibre content and crude protein content. On the other hand, significant differences were observed between grades of palm shoot relative to Brix and moisture content.

Table 3.2: Chemical properties of palm shoot

Chemical Properties ¹	GRADE A	GRADE B	GRADE C
BRIX*	10.2 ± 0.74	10.3 ± 0.67	7.2 ± 0.37
PH	6.6 ± 0.11	6.7 ± 0.06	6.6 ± 0.14
% MOISTURE CONTENT (Wet Basis)*	87.9 ± 0.34	93.2 ± 1.73	92.0 ± 1.36
% ASH (Wet Basis)	1.50 ± 0.207	0.98 ± 0.132	1.08 ± 0.051
% TITRATABLE ACIDITY (Wet Basis)	0.84 ± 0.058	0.79 ± 0.108	0.83 ± 0.116
% ASCORBIC ACID (Wet Basis)	0.49 ± 0.150	0.34 ± 0.059	0.36 ± 0.071
% CRUDE FIBRE (Dry Basis)	8.1 ± 0.85	6.6 ± 0.27	8.6 ± 0.52
% CRUDE PROTEIN (Dry Basis)	17.6 ± 0.64	18.4 ± 1.50	16.4 ± 1.54

± : S.E

¹ Means are based on five replicates

* Means for the three grades are significantly different at p<0.05

3.1.4 Enzymatic browning in palm shoot

Time for browning upon exposure to air, in the three grades of palm shoot A, B and C are presented in Table 3.3 below. No difference was noted between grades of shoot. On the other hand, the greater the reduction in size of the test sample, the shorter the time for browning to occur. Shredded shoots exposed a larger surface area to air than sliced shoot than whole shoot, hence more rapid oxidation of the substrates.

Table 3.3: Enzymatic browning in palm shoot

	Time for browning to occur (min)		
	GRADE A	GRADE B	GRADE C
WHOLE	10	9.75	8
SLICED	3	3.83	2.17
SHREDDED	0.75	0.33	0.7

3.1.5 Inhibition of browning

For all three grades, adequate blanching in hot boiling water was achieved in four minutes. Inhibition of browning using immersion in water and ascorbic acid

treatment are recorded in Tables 3.4 and 3.5 respectively. Ascorbic acid solution proved to be more effective than water at inhibiting browning in palm shoot, and the higher its concentration the more effective its action. Ascorbic acid is an antioxidant and therefore scavenges any available oxygen. Moreover its acid property lowers the pH of the solution and therefore has an inhibitive action on enzymes.

Table 3.4: Inhibition of browning in palm shoot by immersion in water

Time for browning to occur (min)		
GRADE A	GRADE B	GRADE C
15.4	16.3	16.2

Table 3.5: Inhibition of browning in palm shoot by ascorbic acid treatment

Time for browning to occur (min)			
	GRADE A	GRADE B	GRADE C
0.2 % AA*	25.0	19.5	22.0
0.5 % AA	82.5	100	100
1.0 % AA	Absence of browning even after 6 hrs	Absence of browning even after 6 hrs	Absence of browning even after 6 hrs

* AA: ascorbic acid solution

3.2 STAGE TWO: PRODUCT DEVELOPMENT (PICKLING) AND SHELF LIFE STUDIES

3.2.1 Product development

3.2.1.1 Sensory analysis

3.2.1.1.1 Sensory profile

The mean scores for the four palm shoot pickles (one commercial product, *D*, and three palms shoot formulations: *A*, *B* & *C*) were found to be significantly different in the case of all the sensory attributes which were assessed ($p < 0.01$).

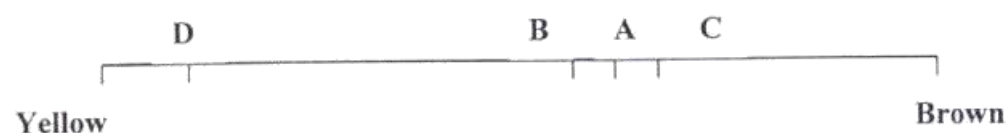


Figure 3.1: Mean colour scores of four formulations of palm shoot pickle

Further statistical analysis (LSD test at 5 % level) generated the results recorded in Table 3.6, which can be summarised as follows:

- Samples A, B and C were similar in the following characteristics: spicy odour, sour odour, hard texture, crunchy texture, chewy texture, salty taste, hot taste, spicy taste and bitter taste.
- Sample D obtained significantly different mean scores from samples A, B and C, for 9 out of the 10 attributes evaluated.
- Sample C differed from samples A and B in one sensory attribute only: samples A and B possessed a moderately intense sour taste while sample C obtained a significantly higher score for this attribute.
- Samples A, B, and C were found to be moderately intense for salty taste and hot taste. On the other hand sample D obtained significantly lower ratings for these attributes. The commercial product also possessed milder spicy odour, sour taste and spicy taste than the three palm shoot formulations.

- Samples A, B and C obtained desirable scores for crunchy, hard and chewy texture, and were better than sample D in these attributes.
- Samples A, B and C scored moderately for bitter aftertaste while sample D obtained a significantly lower rating for this characteristic.

Table 3.6: Mean attribute sequences of four formulations of palm shoot pickle

Attributes		Mean scores of the samples			
		Pickle A	Pickle B	Pickle C	Pickle D
Appearance	Oily	6.6a	4.9b	5.5b	2.5c
Odour	Spicy	5.5a	5.5a	5.8a	3.9b
	Sour	5.5a	4.6a	5.3a	4.8a
Texture	Hard	4.4a	5.2a	4.5a	2.5b
	Crunchy	6.0a	6.4a	6.3a	3.6b
	Chewy	4.5a	4.6a	4.0a	2.7b
Taste	Sour	5.0b	5.2b	6.1a	3.9c
	Salty	4.8a	5.0a	5.2a	4.2b
	Hot	5.2a	5.2a	5.1a	4.1b
	Spicy	5.9a	6.0a	5.8a	3.8b
After-taste	Bitter	4.2a	4.8a	3.9a	1.6b

Any two means in any particular row, shared by a common letter are not significantly different at $p < 0.05$

The above observations are in accord with the trends depicted in Figure 3.2 and Figure 3.3. Visualisation of the profiles of the four samples in Figure 3.2 shows that samples A, B and C have similar sensory profiles. On the other hand, sample D comes out with a different sensory picture compared to A, B and C: the commercial product obtained lower mean scores than A, B and C, in the case of most of the attributes. Furthermore, the spider-web diagram in Figure 3.3 shows that sample D possessed milder taste characteristics and less desirable texture attributes than samples A, B and C.

Based on the above observations, the following conclusions and recommendations can be made:

1. Formulations A, B and C were found to be comparable in all sensory attributes except sour taste.
2. Formulations A, B and C were better than the commercial product in terms of the texture attributes, salty taste and hot taste.

3. Formulations A and B also possessed a more desirable sour taste than the commercial product.
4. Formulation C would need to be adjusted to improve the sour taste.
5. Formulations A, B and C would need to be improved to reduce the intensity of the spicy taste. This would also contribute to reduce the bitter aftertaste.

3.2.1.1.2 In-house Preference Tests

Twenty-six of the fifty-two panellists preferred sample D to sample C. It was thus concluded (using a Two-Tailed Binomial Test) that sample D was not significantly preferred ($p \approx 0.8$) over sample C.

3.2.1.2 Final formulation

The formulation of palm shoot pickle was finalised taking into consideration the recommendations arising from the sensory evaluation. The final formulation is presented in Table 3.7 below.

Table 3.7: Composition of Finalised Palm Shoot Pickle

Ingredients	% Composition (by weight)
Palmshoot	64.90
Chilli	1.00
Salt	1.75
Oil	20.00
Tamarind	8.00
Citric acid	0.30
Turmeric	1.30
Mustard	1.00
Garlic	0.55
Methi	1.20

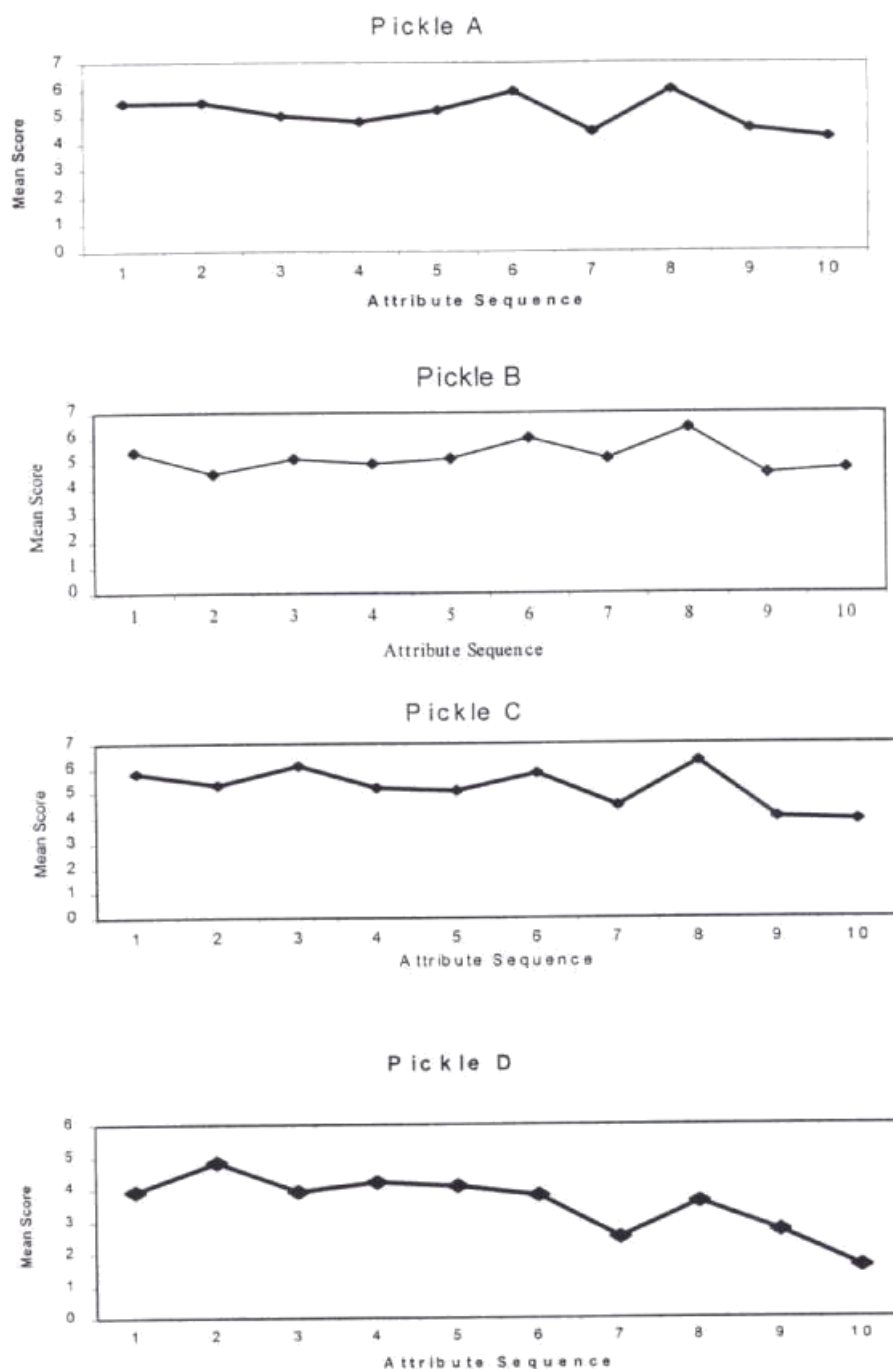


Figure 3.2: Profiles of sensory attributes of four palm shoot pickles
 1: Spicy odour; 2: Sour odour; 3: Sour taste; 4: Salty taste; 5: Hot taste; 6: Spicy taste;
 7: Hard texture; 8: Crunchy texture; 9: Chewy texture; 10: Bitter after-taste

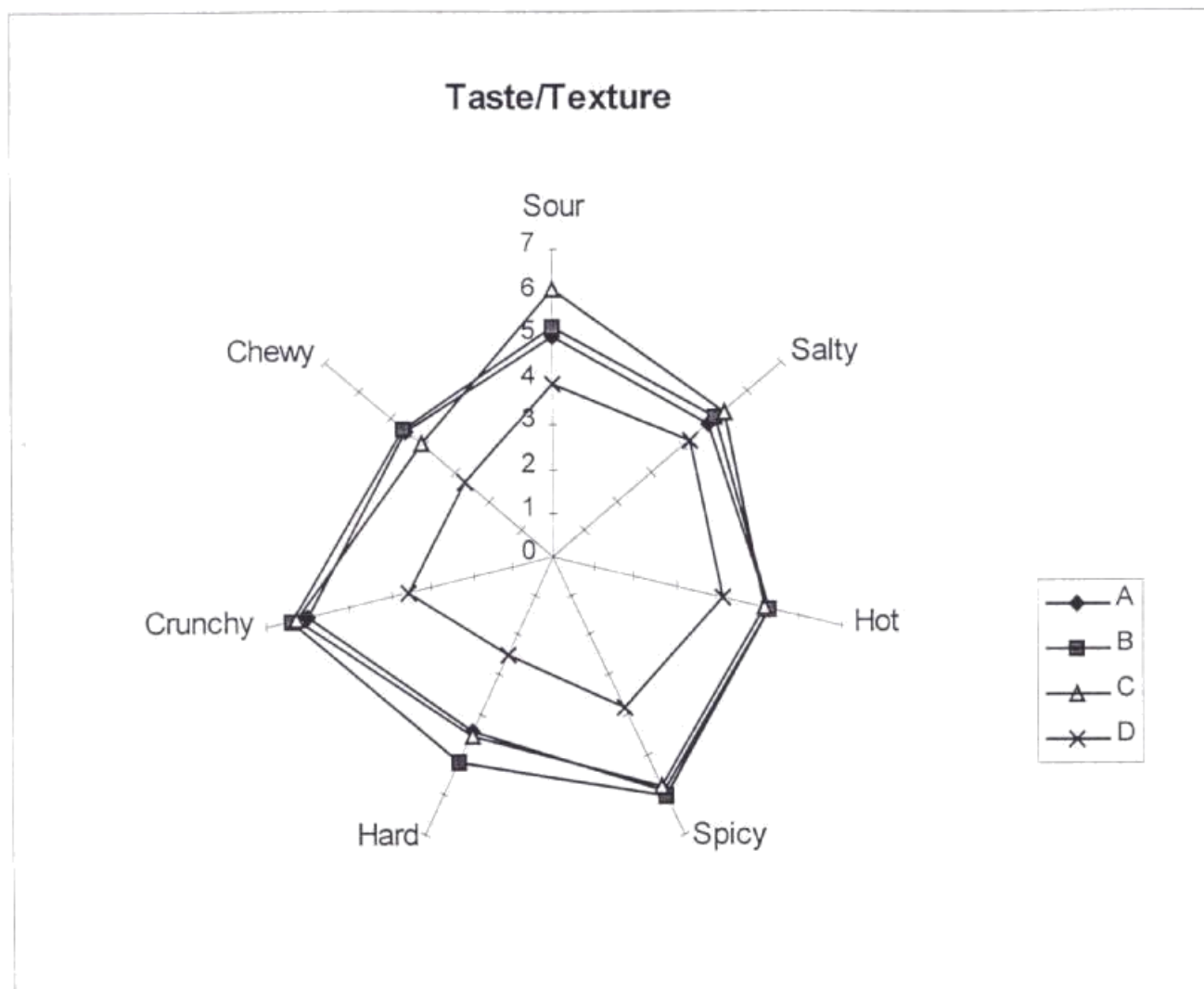


Figure 3.3: Spider-web diagram of the sensory profile of four palm shoot pickles

3.2.1.3 Microbiological analysis

Results pertaining to total viable count, staphylococci and sulphite-reducing anaerobes are tabulated in Tables 3.8 to 3.10 below.

Table 3.8: Mean total viable count per gram of pickle

Time (day)	0	7	14	21	28
Treatment					
Room temperature	5.3×10^5	-	5.5×10^5	8.8×10^5	1.2×10^6
Refrigerated	ng	-	5.5×10^5	6×10^5	1.6×10^6
Opened and refrigerated	ng	-	1.5×10^5	5.5×10^5	8.4×10^6
Incubated at 37°C	-	-	4.7×10^5	-	-

Table 3.9: Mean number of Staphylococcus per gram of pickle

Time (day)	0	7	14	21	28
Treatment					
Room temperature	ng	ng	1.8×10^5	1.6×10^5	6.9×10^4
Refrigerated	ng	ng	2.5×10^5	9.5×10^2	1.5×10^5
Opened and refrigerated	ng	ng	5.2×10^4	1.1×10^2	6.6×10^2
Incubated at 37°C	-	-	9.9×10^2	-	-

Table 3.10: Mean number of sulphite-reducing anaerobes per gram of pickle

Time (day)	0	7	14	21	28
Treatment					
Room temperature	ng	ng	2	3.0×10^1	2.9
Refrigerated	ng	ng	1.8	3.8	1.2×10^1
Opened and refrigerated	ng	ng	1.8	3.4	2.3×10^1
Incubated at 37°C	-	-	4.8	-	-

CFU: colony-forming units

ng: no apparent growth

-: no results

The initial microbial load of the pickle is of the order of 10^5 per g of pickle. This number increased gradually to 10^6 CFUs per g of pickle over the study period of one month. No coliforms were detected in any of the samples tested over the month. The numbers of staphylococcus and clostridia are low and present no safety hazards.

The preliminary study revealed that the handling, preparation and pickling steps were done in a hygienic manner. Nevertheless, as an additional precaution to check microbial growth during storage, it was deemed useful to review the pasteurisation process conditions.

3.2.2 Shelf-life studies

3.2.2.1 Sensory evaluation

The attributes of the pickle stored at room temperature and in the refrigerator over a fifteen-month period are presented in Figures 3.4a to 3.4l.

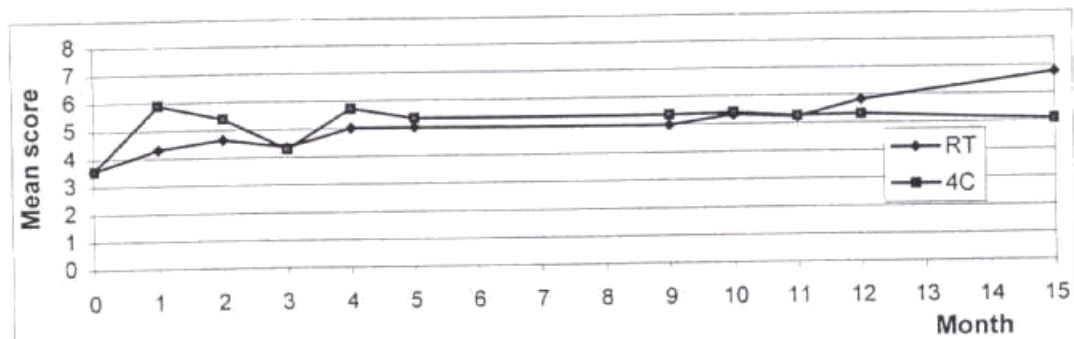


Figure 3.4a: Mean colour of palm shoot pickle

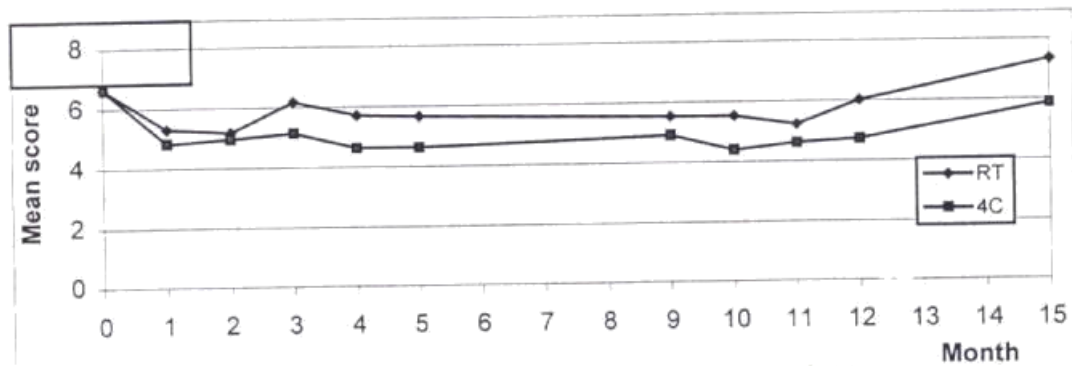


Figure 3.4b: Mean oiliness of palm shoot pickle

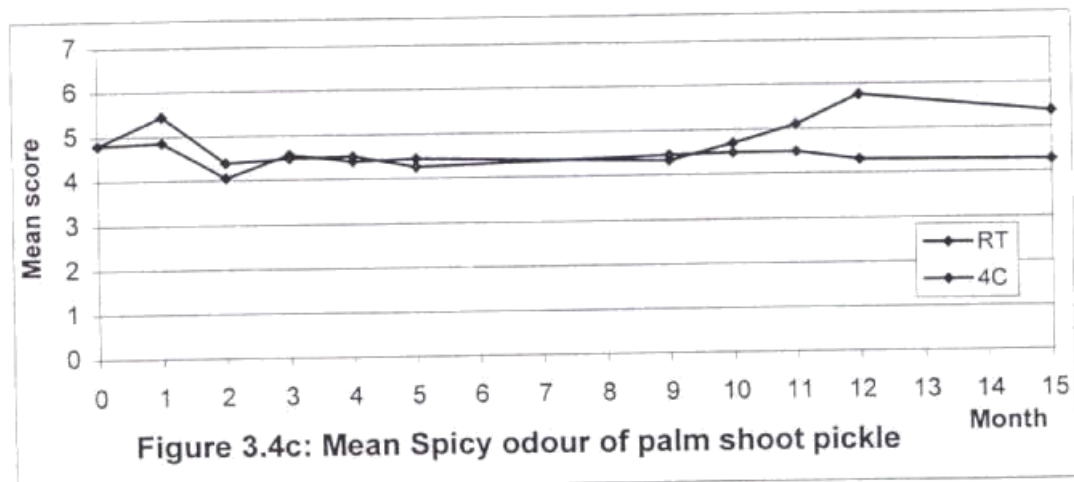
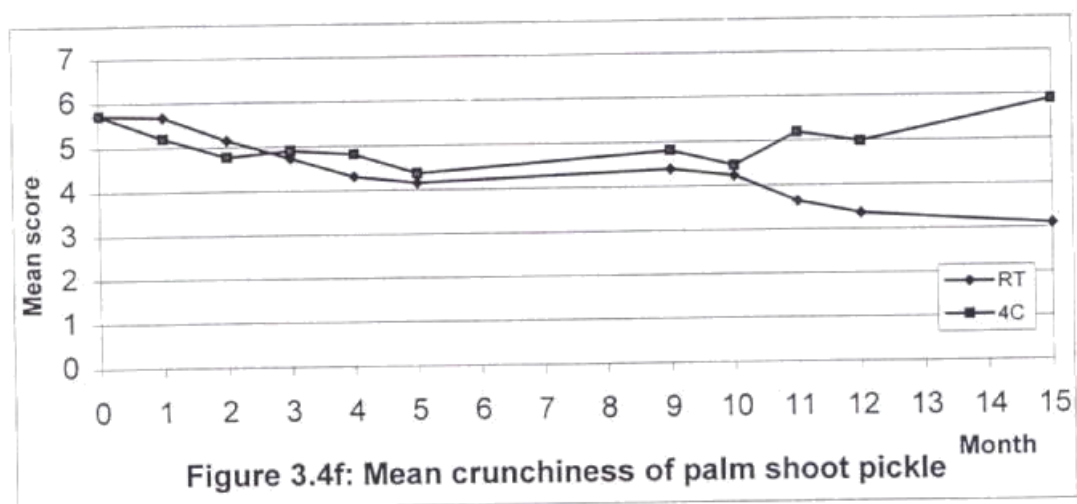
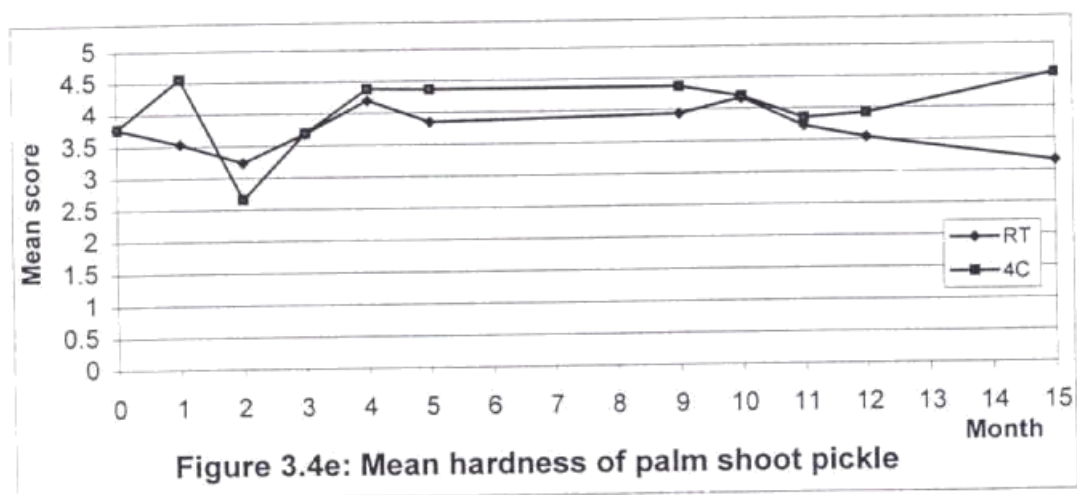
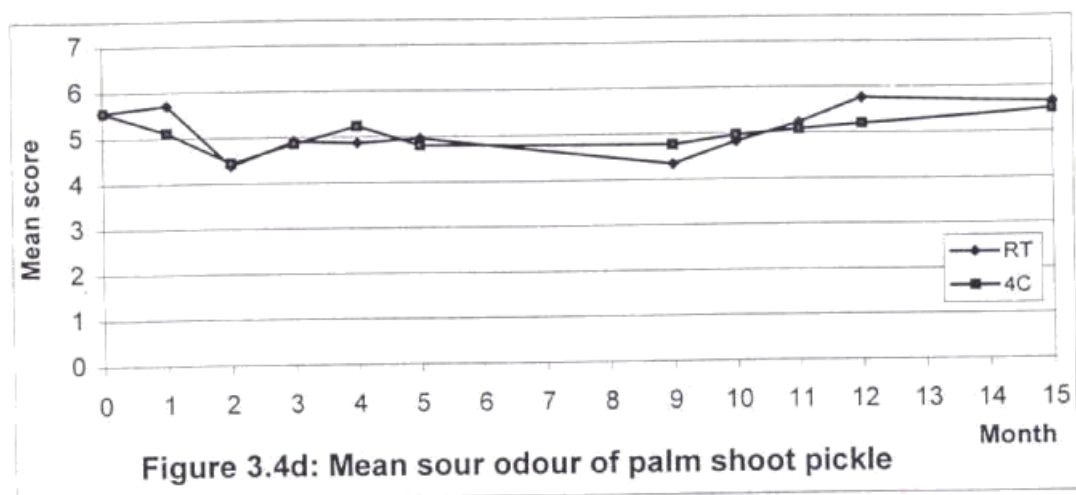
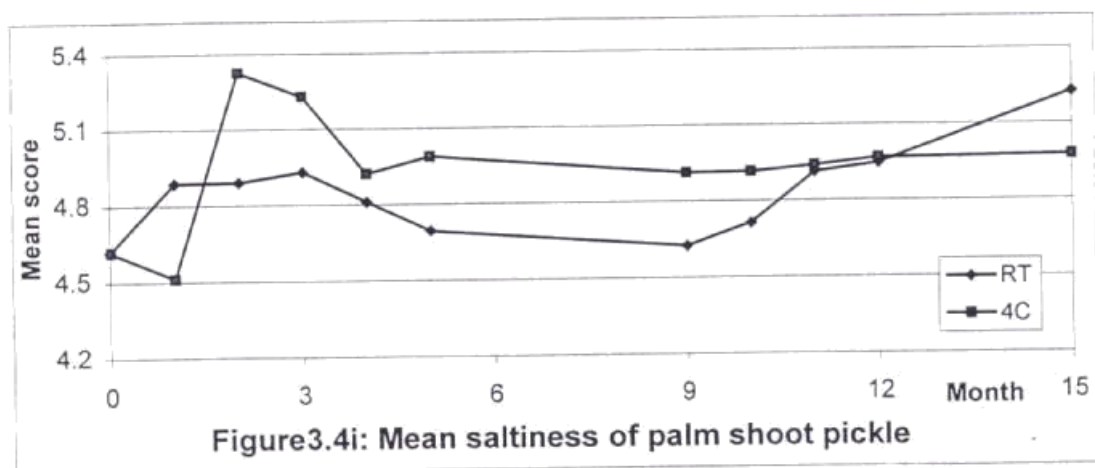
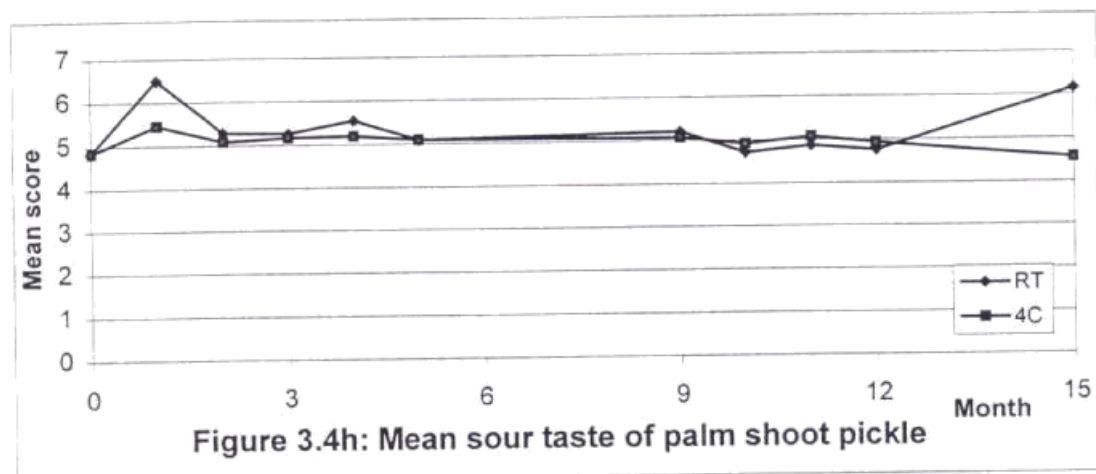
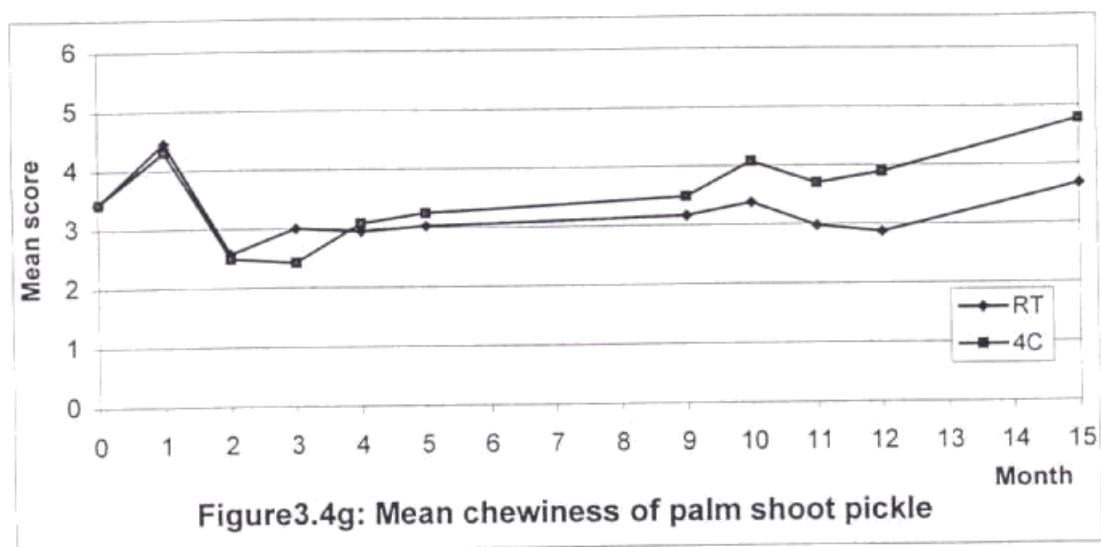
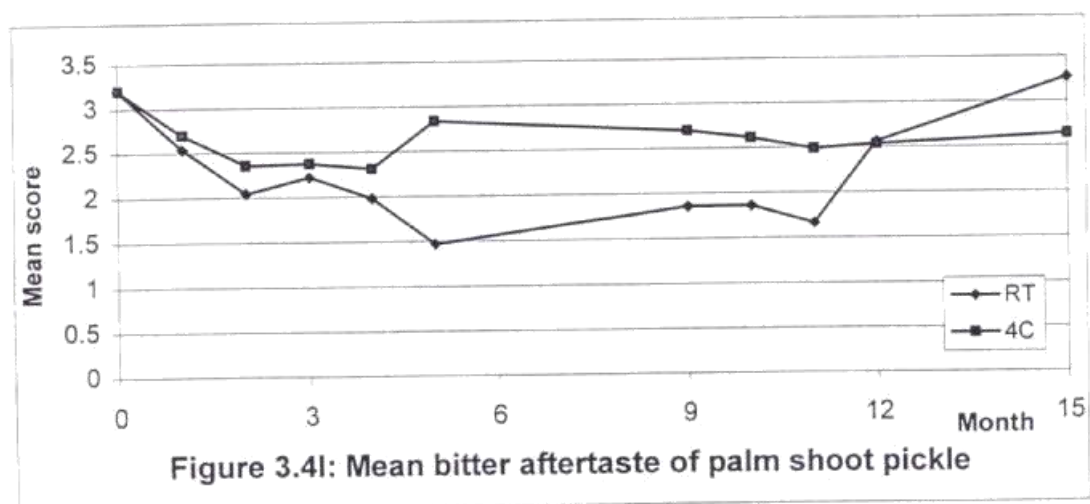
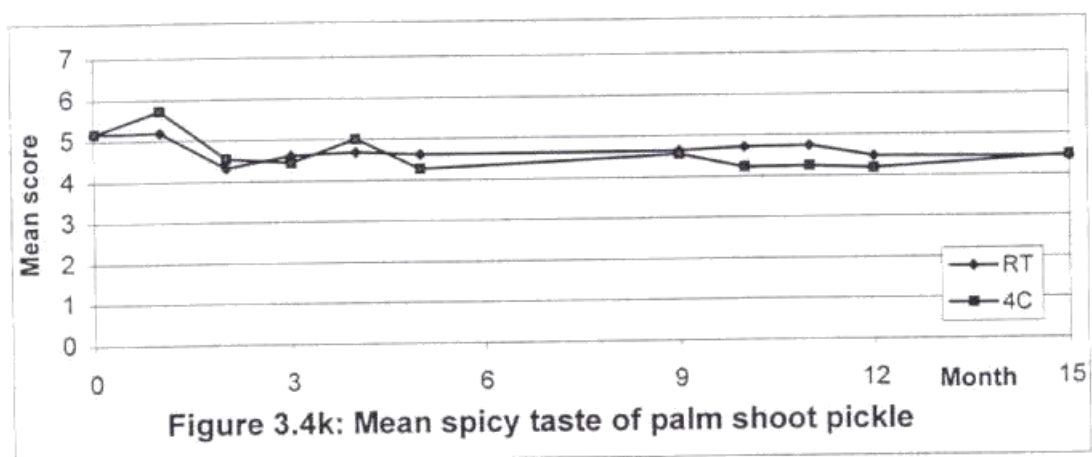
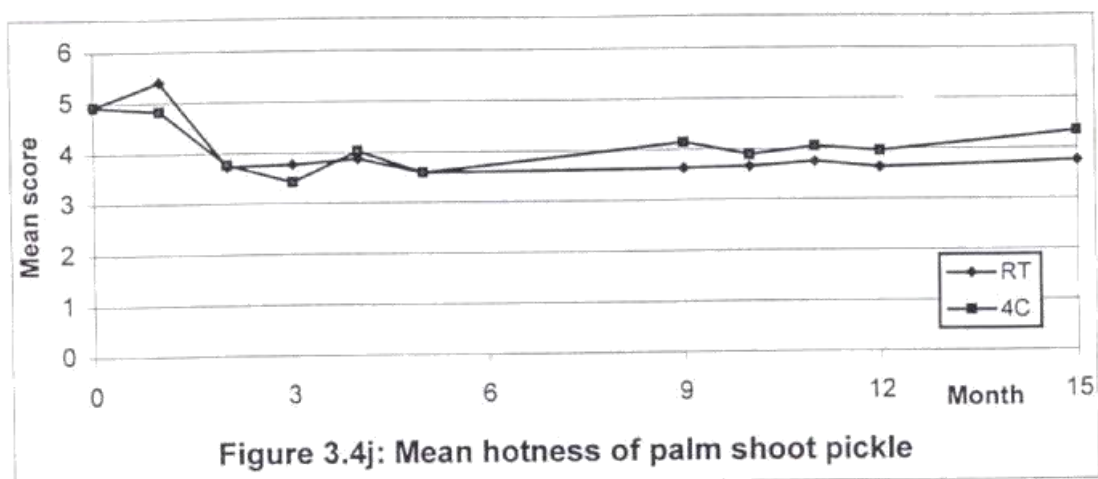


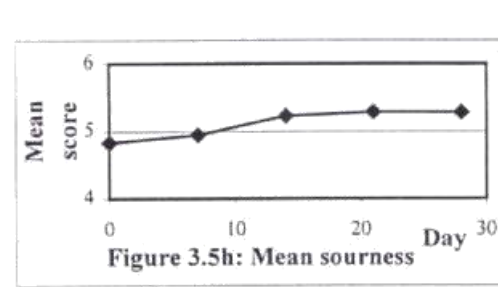
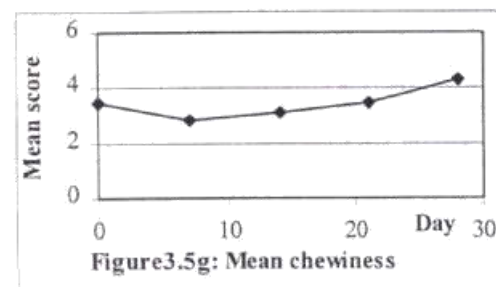
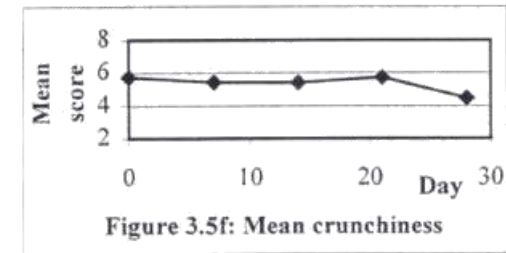
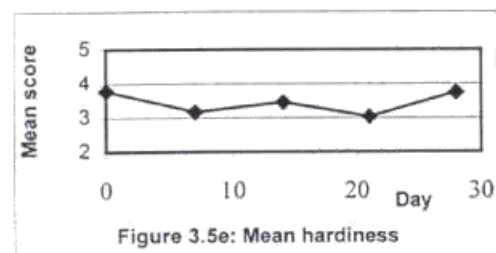
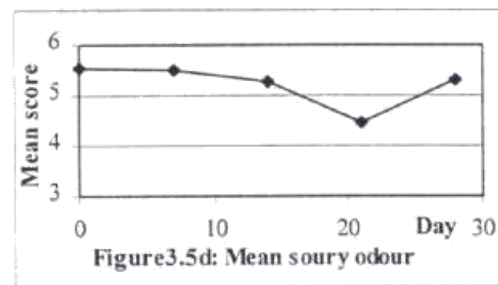
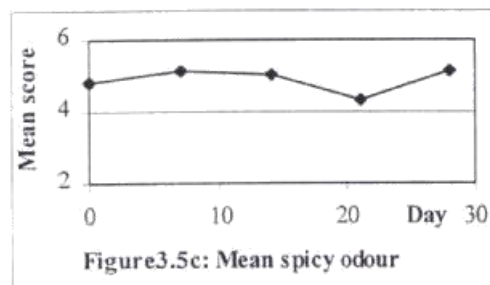
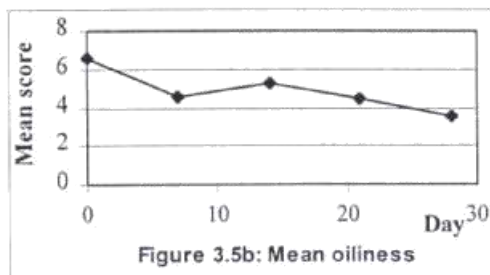
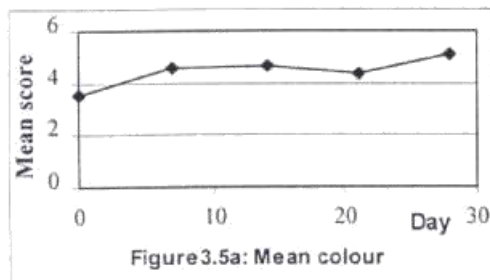
Figure 3.4c: Mean Spicy odour of palm shoot pickle







The attributes for pickles stored in the refrigerator after opening of the jars are presented in Figures 3.5a to 3.5i. The study was done over a one-month period following opening of the jars.



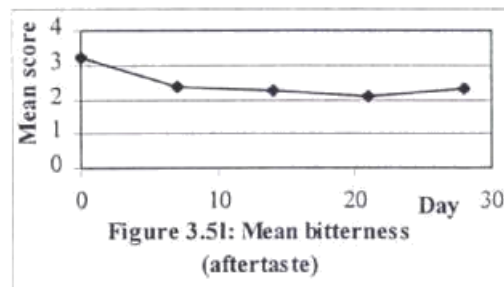
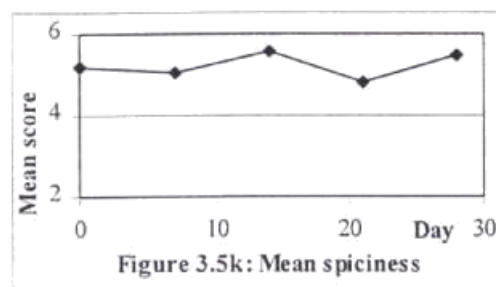
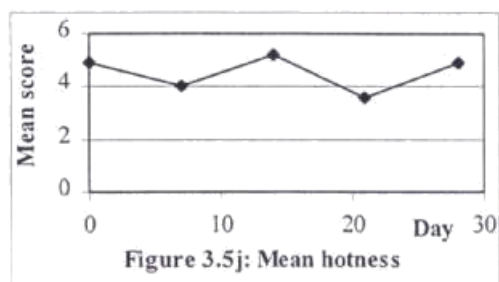
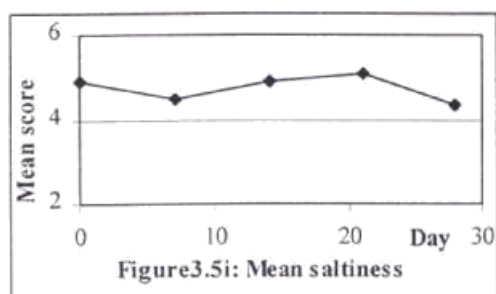


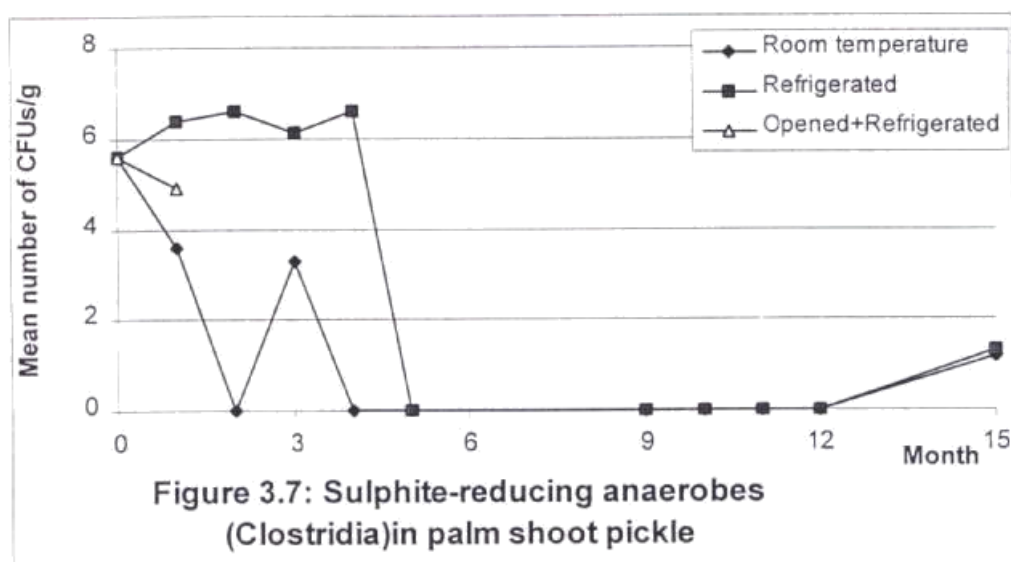
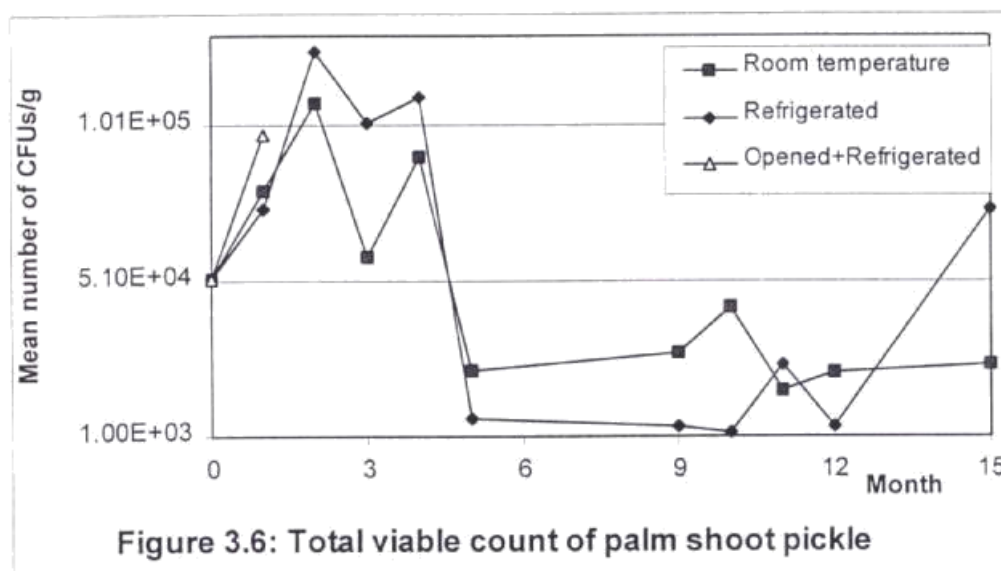
Figure 3.5: Attributes of pickle stored in the refrigerator after opening of jars

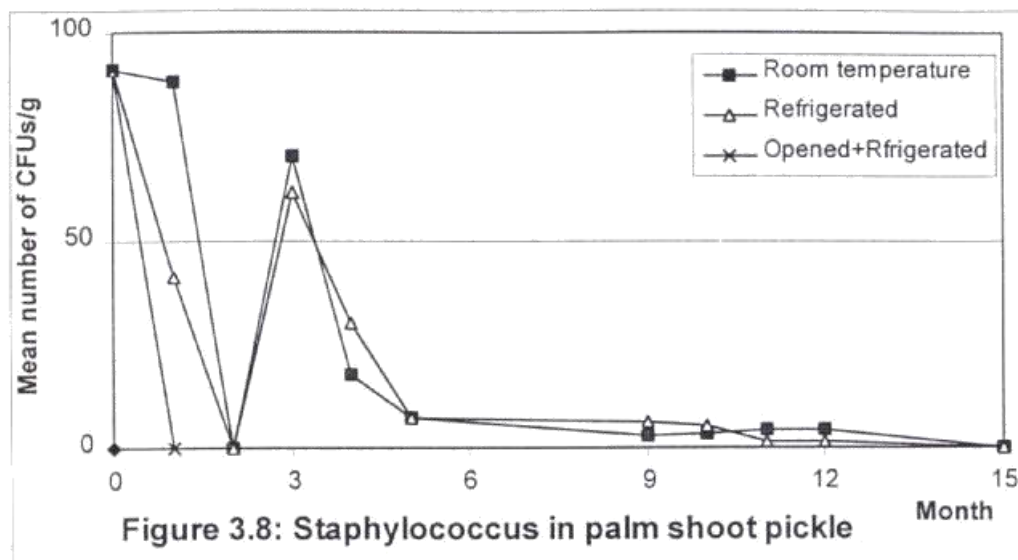
The attributes of pickles stored at room temperature and 4°C and evaluated over the fifteen-month period show no major variability in the sensory characteristics. This indicates that the product maintains its organoleptic qualities to a satisfactory level for fifteen months, both when stored at room temperature and at 4°C.

These observations also hold for the pickle stored in the refrigerator after opening of the jar, with variability within a tolerable limit and no major departures over the storage period. Consumers would therefore perceive no meaningful alterations in the sensory attributes of the pickle once the jar has been opened, provided it is stored in the refrigerator.

3.2.2.2 Microbiological analysis

The number of CFUs (colony-forming units) per gram of pickle relative to the following flora: total viable count, staphylococcus and sulphite-reducing anaerobes are presented in Figures 3.6 – 3.8. Coliforms were not detected in any sample tested. In all cases, the numbers decreased during storage and at all times remained below numbers prescribed in the Food Regulations 1999 for ready-to-eat foods. This shows that the pickles maintained their quality with respect to both spoilage and pathogenic microorganisms.

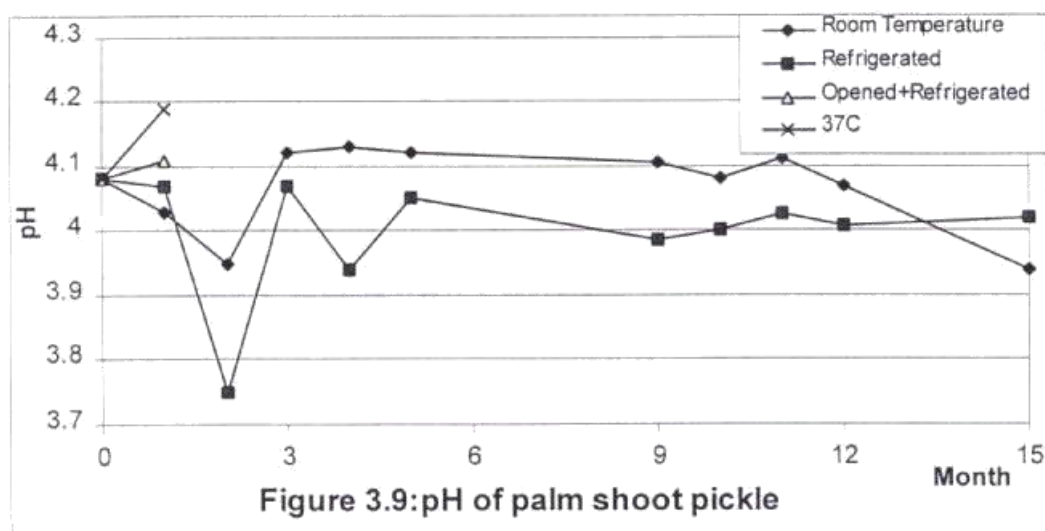




3.2.2.3 Physicochemical analysis

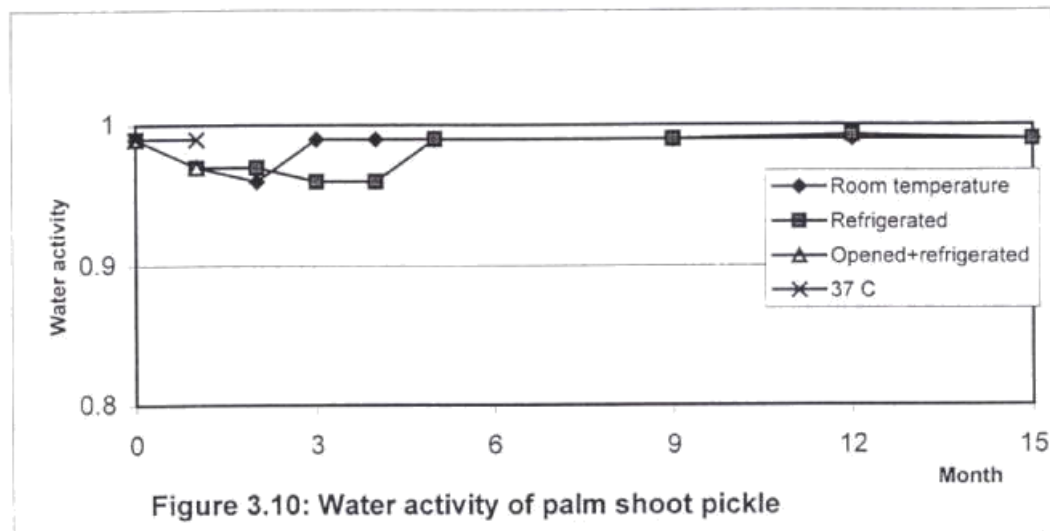
3.2.2.3.1 pH

The pH of the palm shoot pickle remained close to 4.0 over the study period as shown in Figure 3.9. pH of pickles stored at low temperature showed same variation as that of pickle stored at room temperature.



3.2.2.3.2 Water activity

The water activity of the palm shoot pickle varied between 0.97 and 0.99 over the study period. Water activity varies little with temperature. This is reflected in Figure 3.10.



3.3 STAGE THREE: ACCEPTABILITY OF PICKLE & PROCESSING LINE

3.3.1 Consumer-oriented sensory evaluation

3.3.1.1 Degree of liking

90% liked the product moderately or extremely (Figure 3.11). Only 2.7% disliked the product. This is an indication that the product is acceptable.

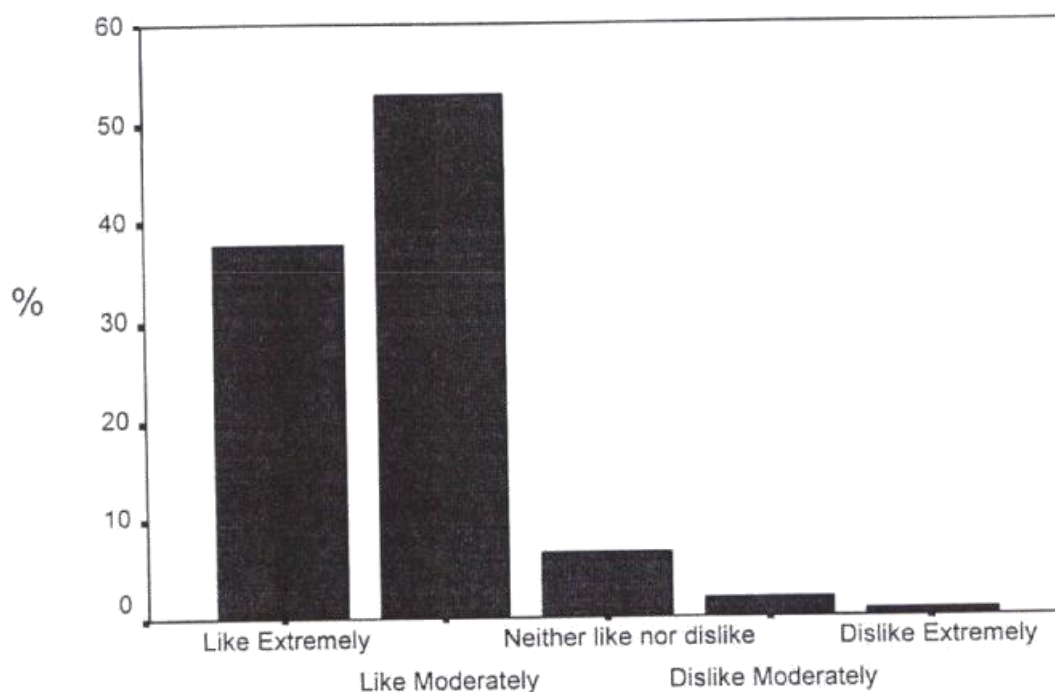


Fig 3.11. Degree of Liking

3.3.1.2 Purchase intent

Around 27% of the sample would '*definitely buy it*' while 67 % stated that they would '*probably buy it*' (Table 3.11).

Table 3.11: Purchase Intent

	Frequency	%
Definitely buy it	82	27.2
Probably buy it	201	66.6
Definitely not buy it	19	6.3
Total	302	100.0

3.3.1.3 Gender, region, ethnicity and degree of liking

It appears that gender and region do not affect degree of liking (Tables 3.12 and 3.13).

Table 3.12: Gender*Degree of Liking

	Like Extremely	Like Moderately	Neither like nor dislike	Dislike Moderately	Dislike Extremely	Total
Male	55	77	6	4	1	143
	38.5%	53.8%	4.2%	2.8%	.7%	100.0%
Female	59	83	14	2	1	159
	37.1%	52.2%	8.8%	1.3%	.6%	100.0%
Total	114	160	20	6	2	302
	37.7%	53.0%	6.6%	2.0%	.7%	100.0%

Table 3.13: Region * Degree of Liking

	Like Extremely	Like Moderately	Neither like nor dislike	Dislike Moderately	Dislike Extremely	
Rural	54	76	7	3	0	140
	38.6%	54.3%	5.0%	2.1%	0%	100.0%
Urban	60	84	13	3	2	162
	37.0%	51.9%	8.0%	1.9%	1.2%	100.0%
Total	114	160	20	6	2	302
	37.7%	53.0%	6.6%	2.0%	.7%	100.0%

Degree of liking seems to be slightly influenced by ethnic group with a Non-Chinese Asian and General population liking the products more extremely (47% & 38% respectively) compared to 28% for the Chinese population (Table 3.14).

Table 3.14. Ethnicity* Degree of Liking

	Like Extremely	Like Moderately	Neither like nor dislike	Dislike Moderately	Dislike Extremely	Total
Chinese	27	57	7	4	2	97
	27.8%	58.8%	7.2%	4.1%	2.1%	100.0%
Non-Chinese Asian	47	49	4	1	0	101
	46.5%	48.5%	4.0%	1.0%	0%	100.0%
General Population	40	54	9	1	0	104
	38.5%	51.9%	8.7%	1.0%	0%	100.0%
Total	114	160	20	6	2	302
	37.7%	53.0%	6.6%	2.0%	.7%	100.0%

3.3.1.4 Gender, region, ethnicity & purchase intent

Purchase intent does not seem to be substantially affected by gender and region (Tables 3.15 and 3.16).

Table 3.15: Gender * Purchase Intent

		Definitely buy it	Probably buy it	Definitely not buy it	Total
Gender	Male	38	96	9	143
		26.6%	67.1%	6.3%	100.0%
	Female	44	105	10	159
		27.7%	66.0%	6.3%	100.0%
Total		82	201	19	302
		27.2%	66.6%	6.3%	100.0%

Table 3.16: Region * Purchase Intent

		Definitely buy it	Probably buy it	Definitely not buy it	Total
Region	Rural	40	91	9	140
		28.6%	65.0%	6.4%	100.0%
	Urban	42	110	10	162
		25.9%	67.9%	6.2%	100.0%
Total		82	201	19	302
		27.2%	66.6%	6.3%	100.0%

As for the relationship between ethnicity and purchase intent, there are indications that Non-Chinese Asian and the General Population would more '*definitely buy*' the product compared to Chinese (Table 3.17).

Table 3.17: Ethnic Group * Purchase Intent

		Definitely buy it	Probably buy it	Definitely not buy it	Total
Ethnic Group	Chinese	20	69	8	97
		20.6%	71.1%	8.2%	100.0%
	Non-Chinese Asian	32	66	3	101
		31.7%	65.3%	3.0%	100.0%
	General population	30	66	8	104
		28.8%	63.5%	7.7%	100.0%
Total		82	201	19	302
		27.2%	66.6%	6.3%	100.0%

Mainly Asians, especially Non-Chinese Asians, traditionally consumed pickle. The study shows that the whole population appreciates currently such products. Geographical location also does not affect degree of liking and purchase intent.

This is comprehensible, as Mauritius being a small island and with the mixing and intermingling of the various cultures and *cuisines*, food preferences are no longer biased by ethnicity, gender and location.

Therefore this product has a very good market potential.

3.3.2 Process flow diagram

The process is divided into three parts, namely the preparation of the shoot, the preparation of spices and preparation of pickle. These three parts are summarised in Figures 3.12 and 3.13.

3.3.2.1 Preparation of palm shoot

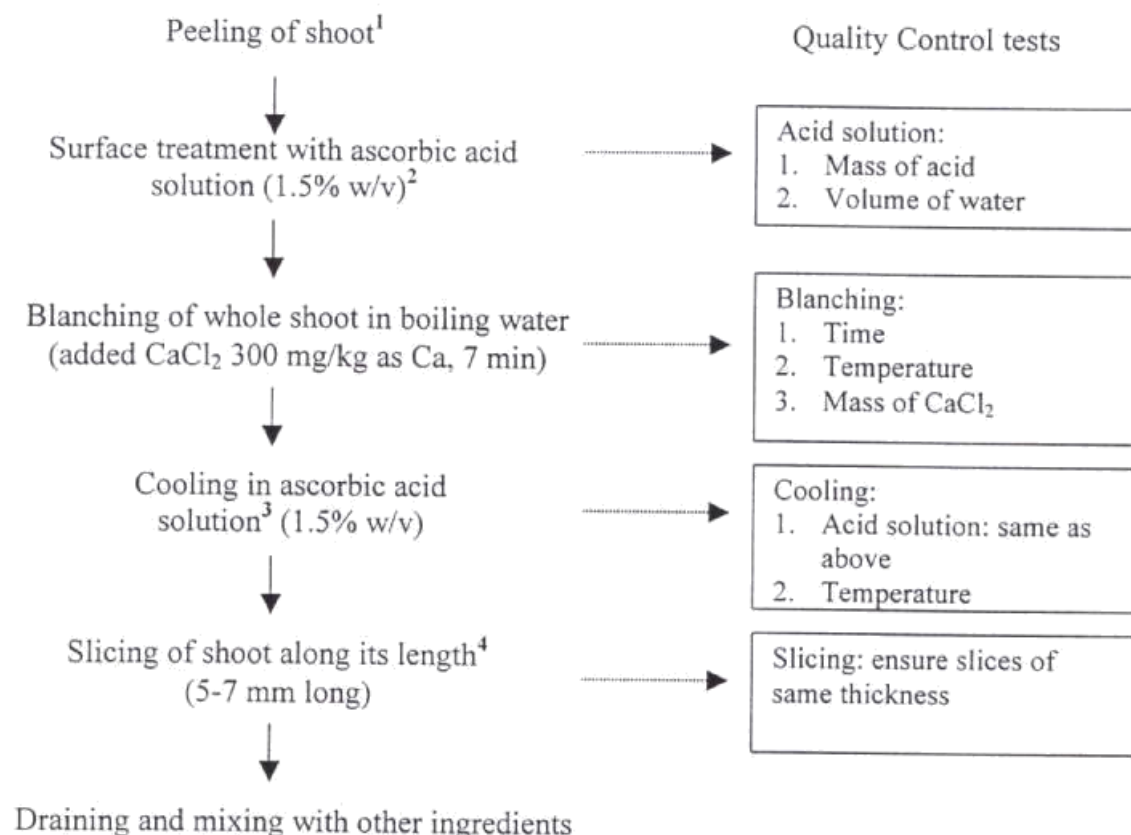


Figure 3.12: Preparation of palm shoot

¹ Peeling of the shoot is done manually.

² It is important to ensure that the shoot is completely immersed in the acid solution.

³ The acid solution can be prepared in iced water to accelerate cooling to ambient temperature. The shoot must remain in the acid solution whilst awaiting the following slicing step.

⁴ Slicing must be done just before mixing with other ingredients.

3.3.2.2 Preparation of spices

All ingredients are available from local suppliers. Dehydrated products were chosen instead of fresh because of their stability and hence their easy storage. Moreover, their low water activity contribute to extending the shelf life of the finished product.

Ingredients are measured according to their compositional amount in the pickle as per Table 3.7. They are then mixed to form a homogeneous blend.

3.3.2.2 Preparation of pickle

The pickle is prepared according to the flow chart in Figure 3.13.

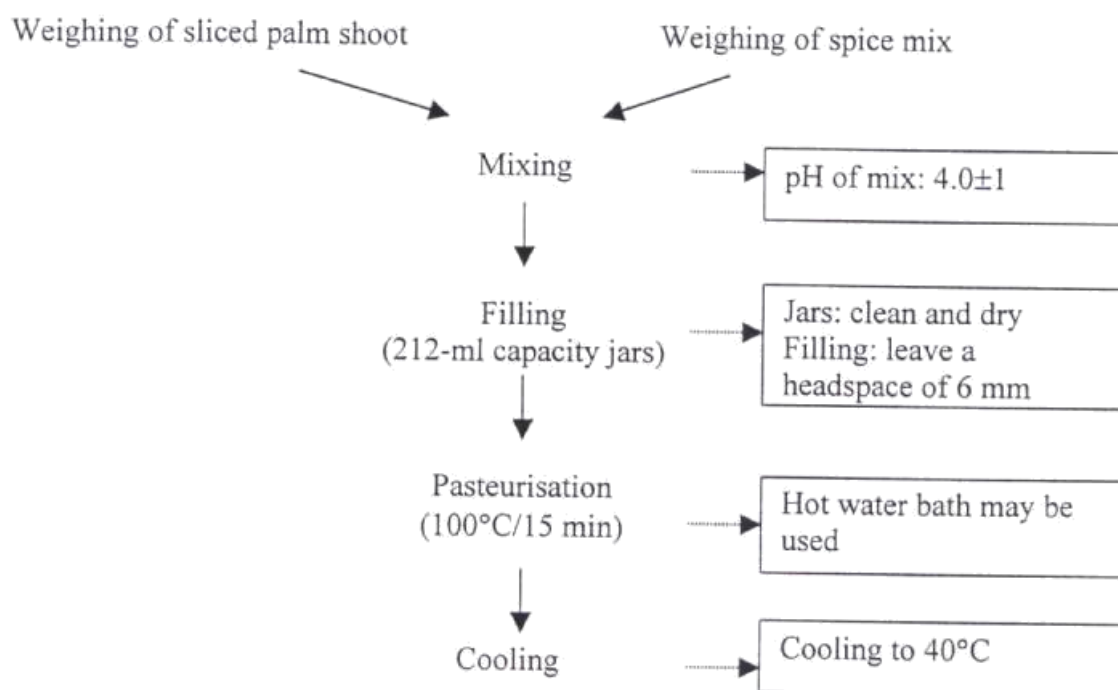


Figure 3.13: Preparation of pickle

3.3.3 Quality Control Tests

Quality of the final pickle depends on the quality of raw material, the handling during processing, and the strict adherence to process conditions. This implies accurate weighing of ingredients, prompt mixing of ingredients, proper filling, adequate pasteurisation and final cooling and drying of jars. Quality control tests will therefore include recording of parameters like weighed masses, pH, time and temperature at appropriate process steps, as have been pointed out in Figures 3.12 and 3.13.

4.0 CONCLUSIONS

4.1 STAGE ONE: CHARACTERISATION OF THE PHYSICAL, CHEMICAL AND SENSORY PROPERTIES OF PALM SHOOT

Results indicate no significant differences ($p>0.05$) between the different grades A, B, C in the physical, chemical and sensory characteristics. This shows that any of the grades could be used for product development. Based on unit costs of shoots, Grade C (shoot circumference, 25-35 mm) was deemed most appropriate for further processing.

4.2 STAGE TWO: PRODUCT DEVELOPMENT AND SHELF LIFE STUDIES

Palm shoot pickle formulation was finalised on the basis of sensory evaluation of different formulations and an in-house sensory evaluation. Shelf life studies indicate good stability of the product over fifteen months with respect to sensory, microbiological and physico-chemical properties when stored both at room temperature and 4°C. Thus market distribution would be possible at ambient temperature thereby not requiring cold chain distribution and marketing.

4.3 STAGE THREE: ACCEPTABILITY OF PRODUCT AND PRODUCTION LINE

Consumer-oriented studies on the product indicate its high acceptability by the Mauritian community at large irrespective of ethnicity, region and gender. Moreover the product has promising market potential based on very favourable purchase intent of consumers.

References

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Meilgaard M., Civille, G. V. and Carr, B. T. (1991). Sensory Evaluation Techniques. 2nd Edition. CRC Press Inc.

Watts, B. M, Ylimaki, L.G, Jeffrey L.E and Elias L.G (1989): Basic sensory methods for food evaluation. IDRC277e Publication. Ontario, Canada.

Annex 1
PRESCREENING QUESTIONNAIRE

HISTORY (PART I)

1. Name :
.....
.....

2. Address :
.....
.....

3. Phone : Age: Gender:

4. Have you ever participated in a sensory evaluation?

Yes

No

If yes, please specify the type of sensory evaluation and the product assessed.

.....
.....
.....
.....

HEALTH (PART II)

1. Do you have any of the following?

Yes

No

Dentures

Oral or gum problems

Food Allergies

Nasal problems

Gastric problems

2. Do you take any medications which affect your senses, especially oral sensitivity, smell or sight?

Yes

No

FOOD HABITS (PART III)

1. Are you currently on a restricted diet? If yes, explain.

.....

.....

.....

.....

2. What is (are) your favourite food(s)?

.....

.....

.....

.....

3. What is (are) your least favourite food(s)?

.....

.....

.....

.....

4. What foods can you not eat?

.....

.....

.....

.....

5. Do you like pickles?

Yes

No

If yes, which ones do you prefer?

.....

.....

.....

.....

Also indicate with a cross, the frequency of consumption.



If no, please indicate why?

.....

.....

.....

.....

5. Do you know how to prepare pickles?

Yes

No

GENERAL (PART IV)

1. Does anyone in your immediate family work for a food company?

Yes

No

2. Rate your ability to distinguish the following sensory/organoleptic characteristics.

Aroma Taste Flavour Texture Mouthfeel
Odour

Better than average

Average

Below average

3. Have you ever consumed palm shoots before?

Yes

No

4. Specify in what forms you have consumed the palm shoots and also indicate your degree of liking of the products (by marking the scale with a cross).

Salad

Low

Moderate

High

Pickles

Low

Moderate

High

Canned

Low

Moderate

High

Others,
specify

Low

Moderate

High

5. Do you regularly purchase or prepare palm shoot products? If so, please give details of the frequency, commercial brands and products prepared.

.....
.....
.....
.....

QUIZ (PART V)

1. How would you describe the difference between flavour and texture?

.....

.....

.....

.....

2. Describe the differences between crispy and crunchy?

.....

.....

.....

.....

3. What are some textural properties of potato chips?

.....

.....

.....

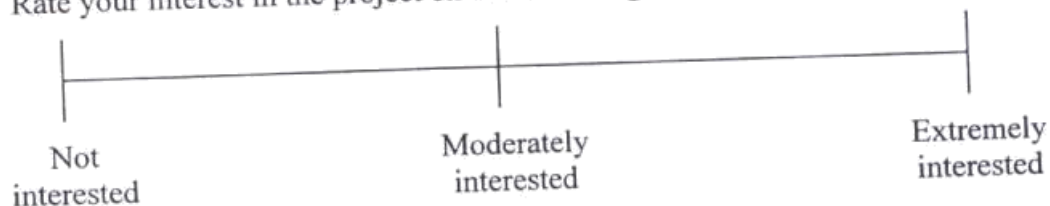
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PART VI

1. Are you agreeable to participate in the palm shoot project?

Yes**No**

2. Rate your interest in the project on the following scale with a cross.



3. Will you be available for sensory evaluation sessions at the following times

- 8:00 – 9:00 and 16:00 – 17:00 during weekdays **Yes** **No**
- 8:00 – 13:00 on Saturday **Yes** **No**

Thank you for completing the questionnaire. Any personal information given will remain confidential.

Annex 2

Taste Recognition Test

NAME _____

DATE _____

Please taste each of the solutions. The solutions may taste sweet, sour, salty or bitter. Identify the taste solution in each coded cup. Rinse your mouth with water before you begin tasting and also between each sample. Crackers are also provided to clear the mouth between samples.

Code

Taste

_____	_____
_____	_____
_____	_____
_____	_____

Thank You

Triangle Test

NAME _____

DATE _____

You are presented with three samples, two of which are the same and the third is different.

Please taste them and try to identify the sample, which you think is different and write the code number below.

It is essential that you make a decision even if you are unsure.

CODE _____

Any comments:

Thank you.

Odour Recognition Test**NAME** _____**DATE** _____

The covered vials contain odourous substances commonly found in the home or workplace. Bring the vial to your nose, remove the cap, take three short sniffs and try to identify the odour. If you cannot think of the exact name of the substance, try to describe something which this odour reminds you of.

Code**Odour**

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Thank You

Threshold test

NAME _____

DATE _____

You are presented with a series of solutions numbered from 1 to 10 in order of increasing strength.

Starting with sample 1, which is the reference, taste the solutions in order comparing each with the reference.

Stop when you detect a difference (even if you cannot describe the difference) and circle the appropriate number below.

Continue until you can describe the difference in taste from the reference. Please tick the number and describe the taste.

Solution number: 1 2 3 4 5 6 7 8 9 10

Description: _____

Thank you.

Annex 3

Profile development

NAME: _____

DATE: _____

Please examine, smell and taste the three samples in front of you. Write down **all** the descriptive terms that come to you including colour, odour, texture, taste and after-taste.

Samples	117	611	581
Colour			
Odour			
Texture			
Taste			
After-taste			

Thank you.

Annex 4

Profiling of palm shoot pickle

NAME:

DATE:

You will find a sample of palm shoot pickle in front of you. There are five categories to assess. Within each category there are various attributes to score (except colour).

Mark the point of the line which indicates your perception of the intensity of the particular attribute, with a cross. You can score nil if you wish.

Use water to rinse your mouth between samples. If you have any questions please ask.

Sample code

Category: APPEARANCE

No. of attributes: 2

Attribute

1. Colour



2. Oily



Category: ODOUR

No. of attributes: 2

Attribute

1. Spicy



2. Sour



Category: TEXTURE

No. of attributes: 3

Attribute

1. Hard



2. Crunchy



3. Chewy



Category: TASTE
No. of attributes: 4
Attribute

1. Sour



2. Salty



3. Hot



4. Spicy



Category: AFTER-TASTE
No. of attributes: 1
Attribute

1. Bitter



Thank you.

Annex 5

Preference test

Name: _____ Date: _____

Taste the two palm shoot pickle samples in front of you, starting with the sample on the left. Circle the number that you prefer. You must choose a sample.

631

228

Annex 6

Profiling of palm shoot pickle during storage

NAME:

DATE:

You will find a sample of palm shoot pickle in front of you. There are five categories to assess. Within each category there are various attributes to score (except colour).

Mark the point of the line which indicates your perception of the intensity of the particular attribute, with a cross. You can score nil if you wish.

Use water to rinse your mouth. If you have any questions please ask.

Sample code _____

Category: APPEARANCE

No. of attributes: 2

Attribute

1. Colour



2. Oily



Category: ODOUR

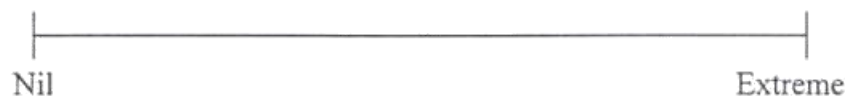
No. of attributes: 2

Attribute

1. Spicy



2. Sour



Category: TEXTURE

No. of attributes: 3

Attribute

1. Hard



Annex 7

Consumer-oriented Sensory Evaluation of Palm shoot pickle

Date:

Questionnaire No.:

Please tick the appropriate box:

Male ☐ Female ☐
 Rural ☐ Urban ☐
 Chinese ☐ Non-Chinese Asian ☐ General Population ☐

Please rate your degree of liking of the palm shoot pickle:

Like extremely ☐
 Like moderately ☐
 Neither like nor dislike ☐
 Dislike moderately ☐
 Dislike extremely ☐

If this product was offered for sale, would you

Definitely buy it ☐
 Probably buy it ☐
 Definitely not buy it ☐

Any other comments:

.....

Thank you.

Interviewer code: