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STUDIES OF HARNESSING QUALITY ATTRIBUTES OF CONDIMENT POWDER (IRU) PROCESSED FROM SOY (*Glycine max*) AND AFRICAN LOCUST BEAN (*Parkia biglobosa*) SEEDS

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ABSTRACT

This study harnessed the quality attributes of condiment powder (iru) processed from soy and African locust bean seeds using calabash and plastic as fermenting containers. The soy and African locust bean-condiment powders were comparatively evaluated with reference-condiment based upon storability for 8-weeks on moisture gain or loss and microbial counts, and 3-weeks colour evaluation were carried out. Sensory analysis was done using students of the Department of Food Technology, University of Ibadan. The design of the experiment was carried out using completely randomized design. The results revealed increase in moisture throughout the weekly storage study as the concluding 8-week showed highest in reference-condiment (14.78 %) and lower in soy-condiment powder (10.03 %) produced in plastic. Microbial count ranged from 4.74 to 5.07 log_{10} cfu/mL and no detection of fungi in all condiment powder samples. However, coliform was present only in control-condiment (0.73 log_{10} cfu/mL). Weekly storage studies on total viable count of soy and African locust-condiment powders ranged from 4.74-5.07 (week 0); 4.93-5.05 (week 1); 4.66-5.47 (week 2); 4.11-5.07 (week 3); 4.20-5.59 (week 4); 4.51-5.76 (week 5); 4.75-5.88 (week 6); 4.01-5.28 (week 7) and 4.48-5.62 (week 8) log_{10} cfu/mL. The degree of lightness (L*), redness (a*) and yellowness (b*) on soy and locust bean-condiment powders produced in a plastic had optimum scores but lower in reference-condiment. General acceptability was highest in soy-condiment powder produced in plastic. Plastic container can be use for the processing of condiment powder without any adverse effect on the final product.

Keywords: African locust bean, soy bean, containers, powdered condiment, moisture gain

INTRODUCTION

Powders obtained from plant materials such as soy and African locust beans represents a promising market since they maintain the natural characteristics of the raw material, they are more chemically and microbiologically stable and easily reconstituted (Sakar *et al.*, 1993). Condiments can be used as food additives to enhance flavor, taste and color to several foods (Bhandari *et al.,* 2007). Moreover, products in powdered form have lower volume and weight, which entails lower costs with storage, packaging and transportation (Dova *et al.*, 2007; Doymaz, 2011). In this context, using alternative fermentor to process soy and African locust beans to condiment powder may represent a technological alternative to preserve and add value to the condiments. Condiments are defined as products obtained from mixture of spices and others, fermented or unfermented ingredients used to add flavor or aroma to foods and beverages.

Condiments improve the palatability of monotonous diets which are composed by staple foods (Spohrer *et al.,* 2013). When biological materials are exposed to an environment it either losses or gains water which could hinder the life span of the products.

However, food products undergo different types of deteriorative changes during storage such as moisture gain or loss, alteration of colour or appearance, taste, aroma and texture. Hence, it is very important to know their storage life under ambient temperature (25 ^{o}C), during which, no appreciable deterioration in quality and acceptability occurs. The various factors that affect food stability include humidity, oxygen, toxic vapors, physical contaminations, light and time-temperature history of the processing package (Khanna and Peppas, 1982). Two major deteriorative reactions viz, moisture gain or loss and oxidative rancidity govern the life of fat rich-powdered products during packaged storage. Dry food systems can lose their desired crispiness during storage or upon opening of the package; loss of crispiness, appearance and aroma due to moisture uptake is a major cause of condiments rejection by consumers (Robertson, 2006). Powdered condiments were reported to lose their flavor and become rancid as water activity increased through moisture gain (Hsieh *et al.,* 1990). However, water activity (a_w) helps to predict safety and stability with respect to microbial growth, chemical and biochemical reaction rates, sensory and physical properties.

Therefore, by checking moisture gain or loss on soy and locust bean-condiment powders produced using alternative methods would suffice information on storability of condiments without salting and freezing. Various researchers have tried to model the deteriorative reactions of dry products during storage studies, based either on moisture migration or lipoid oxidation (Yan *et al.,* 2008; Gomes *et al.,* 2010). Predicting the shelf life of a product based on moisture migration during storage, however, has not been studied. The aim was designed to predict the storage life of soy and locust bean-condiment produced in plastic and calabash as an alternative method in processing of condiment.

MATERIALS AND METHODS

Collection and Preparation of Materials

African locust bean, soybean, calabash, sack, banana leaves and the packaging materials were purchase from Bodija Market in Ibadan, Oyo State, Nigeria. The preparation of samples and production of soy and locust bean-condiment powders was done in the Food processing Laboratory of the department of Food Technology, University of Ibadan.

Production of dried fermented soybean

Soybean was prepared using the method described by Farinde *et al.,* (2007). Five hundred grams of soybean was sorted, cleaned and boiled in water for 2 h using a pressure pot to soften the seeds. The seed coats were removed by pressing in a cleaned mortar and pestle. The seeds were then washed, rinsed in water and drained after which about 100 g was wrapped. Fermented process was allowed to take place for 72 h. The fermented samples were dried in an oven at 60 ^{o}C for 24 h. Dried samples were ground into powder form and stored in a plastic container for subsequent analysis. The soy and locust bean-condiments were produced using plastic and calabash containers.

Production of dried fermented African locust beans

The locust bean was prepared using the method described by Ogunshe *et al.* (2006). Five hundred grams of African locust bean was handpicked to remove dirt and debris. The seeds were cooked for 2 hrs in a pressure pot for easy dehulling of seed coat by pressing in a cleaned mortar and pestle. The dehulled seeds were then re-boiled for 1 hour to soften the seeds. The seeds were washed in water and drained after which 100 g of the seeds were wrapped. Fermentation process of the condiments was allowed to take place for 72 hrs, fermented samples were dried in an oven at 60 ^{o}C for 24 hrs and ground to fine powder. The condiment powders were labeled as (SIP – soy-condiment powder produced in plastic; SIC – soy-condiment powder produced in calabash; PIP – locust bean-condiment powder produced in plastic; PIC – locust bean-condiment powder produced in calabash; and CIC – control condiment).

Study on storage stability

The packaged soy and locust bean-condiment powders were subjected to storage stability test for 8 weeks at ambient temperature at 7 days interval. The packaged products were assessed weekly to determine moisture gain or loss, microbiological analysis (Total viable count), colour and sensory evaluations.

Moisture content determination

Moisture content was determined by (AOAC, 2010) using oven drying method. Two grams was accurately weighted into a previously weighted crucible. The crucible plus sample taken was transferred into the oven at 105 ^{o}C for 2 hrs. After this, the sample was removed from the oven, transferred inside the dessicator and allowed to cool at room temperature. The sample was weighed immediately after cooling. The procedure was repeated until a constant weight of sample is achieved and the final weight of the sample was recorded.

Calculation: $\% \text{ moisture content (M.C)} = \frac{w_1 - w_3}{w_1 - w_0}$ ……. (1)

Weight of the sample prepared for drying in (g) = W_0

Weight of the sample plus crucible before drying in (g) = W_1

Weight of the sample plus crucible after in (g) = W_2

Weight of the sample plus crucible before drying in (g) = W_3

Microbiological Analysis

Soy and locust bean-condiment powders were packaged in sterilized bottles, labeled and taken to laboratory for analysis. The total viable, total coliform and fungi counts of locust bean and soy-condiments were evaluated as stated below.

Media Preparation

One milliliter of sample was aseptically pipetted into a test tube containing nine milliliters sterile distilled water and serial dilution was made to make 10^{-4} dilution. Growth media was prepared according to the specifications on the containers. Plate count agar (PCA) was used for total viable count, Potato dextrose agar (PDA) was used for fungal count while MacConkey agar (MCA) was used for coliform count.

Total Viable Count (TVC)

One milliliter each from 10^{-4} dilution was taken and pipetted into sterile Petri dishes, sterilized and cooled. Plate count agar was poured into the samples aseptically using the pour plate method. The mixture was made to cover the bottom of the Petri dishes by rotating the dishes. It was then allowed to solidify. The plates were inverted and incubated at 37 ^{o}C for 48 hr. Colonies were counted and recorded as colony forming units/ml of sample (Olutola *et al.,* 1991).

$$\text{Total viable count (TVC)} = \frac{\text{ml of sample x no of colonies}}{dilution\ factor} \ldots\ldots\ldots\ldots\ldots \text{(2)}$$

Fungal Count

One milliliter of the aliquot was taken and pipetted into sterile Petri dishes, sterilized and cooled. Potato dextrose agar was poured into the samples aseptically using the pour plate method. The plate was rotated to cover the Petri dishes. The mixture was allowed to solidify with plate inverted and incubated at 37 ^{o}C for 72 hrs after which the colonies were counted (Olutola *et al.,* 1991).

Coliform Count

One millilitre from the aliquot was taken and pipetted into sterile Petri dishes, sterilized and cooled. MacConkey agar was poured into the samples aseptically using the pour plate method. The mixture was made to cover the bottom of the Petri dishes by rotating the dishes. It was then allowed to solidify. The plates were inverted and incubated at 37 ^{o}C for 24 hrs after which the colonies were counted (Olutola *et al.*, 1991).

Colour Evaluation of soy and locust bean-condiment Powders

The colour of the samples was measured using a method described by Rocha and Morais (2003) with a hand held tristimulus reflectance colour meter (Konica Minolta chroma meter CR-400 series, made in Japan). The colour was recorded using a CIE-L *a*b* uniform colour space (-Lab). Where L* indicates lightness; a* indicates chromaticity on a green (-) to red (+) axis; b* chromaticity on a blue (-) to yellow (+) axis. Numerical values of a* and b* were converted into hue angle and chroma value (Francis, 1980). The H0 is an angle in a colour wheel of 36003, with 00, 900, 1800 and 2700 representing the hues red-purple, yellow, respectively. It was derived as the arctangent of the ratio of CIE a* to CIE b* expressed as degrees.

Sensory evaluation of soy and locust bean-condiment powders

A 9-point hedonic preference scale (colour, taste, aroma, texture and overall acceptability) were used to assess the acceptability of powdered condiment made from soy and locust beans using 30 trained panelists. Panelists were selected from student of the Department of Food Technology, University of Ibadan, Nigeria. The selected students were those accustomed to eating condiment. Prior to the sensory analysis, they were screened with respect to their interest and ability to differentiate food sensory properties.

Statistical Analysis

Experiments were replicated three times and the collected data were subjected to the analysis of variance using a completely randomized design. The difference between the means was separated using Duncan Multiple range test and significance difference was taken at 5% confidence limit.

RESULTS

Weekly determination of moisture content in locust bean and soy-condiment powders

Figure 1 showed the determination of moisture content in 8 weeks storage stability of soy and locust bean-condiment powders. The moisture content in week 0 varied significantly ($p<0.05$) from 5.73 to 6.65 %. Highest score was revealed in CIC and lowest value was recorded in SIP. Week 1 have no significant difference ($p>0.05$) as CIC appeared highest (7.09 %) and minimum value was recorded in SIP. The storage stability of week 2 had highest value in 7.70 % while sample CIC had lowest moisture content. There was no significant ($p>0.05$) difference in the sample condiments. Moving to week 3, PIP was ranked highest (9.47 %) but CIC scored lowest (7.68 %) value. Week 4 differ significantly ($p<0.05$) where SIC revealed optimum (10.72 %) value and PIC had minimum (8.83 %) moisture content. Proceeding to week 5, SIC scored highest (10.97 %) and PIC had lowest (8.73 %) content in moisture. The highest value (10.95 %) was recorded in SIC and decreased content was observed in SIP for week 6. The condiment powders produced from soy and locust beans in weeks 7 and 8 had substantial high moisture content. Sample CIC had highest score (13.31 and 14.78 %) and lowest occurred in SIP (10.04 and 10.03 %) for weeks 7 and 8 respectively.

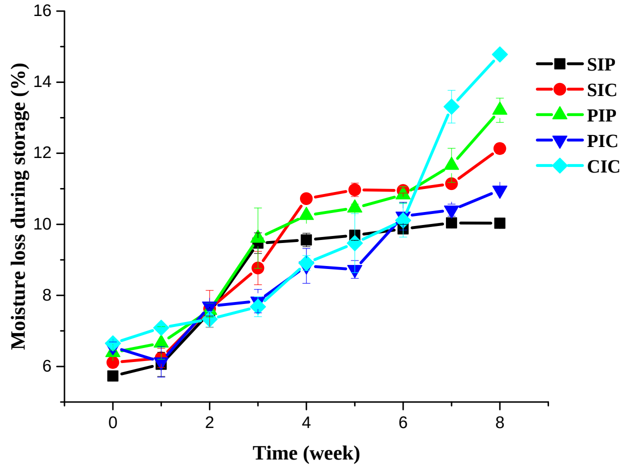

Figure 1: Weekly Moisture gain or loss during storage of soy and locust bean-condiment powders

Key: SIP = soy-condiment powder produced in plastic; SIC = soy-condiment powder produced in calabash; PIP = locust bean-condiment powder produced in plastic; PIC = locust bean-condiment powder produced in calabash and CIC = control condiment.

Microbial count of soy and locust bean-condiment powders

The microbial count of soy and locust bean-condiment powders was summarized in Table 1. With the exception of sample CIC, there was no presence of coliform count in the sample condiment powders. Fungi were not detected in all the condiment powders.

Table 1: Microbial count of soy and locust bean-condiment powders (log_{10} cfu/ mL)

Sample code	**Total viable count x 10^2**	**Coliform**	**Fungi**
SIP	5.00 ± 1.98^a	NIL	NIL
SIC	4.97 ± 2.15^a	NIL	NIL
PIP	5.03 ± 1.86^a	NIL	NIL
PIC	4.74 ± 2.13^a	NIL	NIL
CIC	5.07 ± 2.09^a	0.73±1.27	NIL

Mean standard deviation values not accompanied by the same superscript across the columns are significantly different at $P < 0.05$.

Key: SIC: soy–condiment powder produced in calabash; SIP: soy–condiment powder produced in plastic; PIC: Locust bean–condiment powder produced in calabash; PIP: Locust bean-condiment powder produced in plastic and CIC: Locust bean-control condiment

Weekly total viable count of soy and locust bean-condiment powders

Total viable count of the condiment powder produced from soy and locust bean-condiment powders was presented in Table 2. Sample CIC had optimum counts throughout the storage studies. There was no significant difference (p>0.05) among the condiment powders.

Table 2 Weekly total viable count of soy and locust bean-condiment powders (log_{10} cfu/mL)

Weeks	SIP	SIC	PIP	PIC	CIC
0	5.00± 1.98[a]	4.97±2.15[a]	5.04±1.86[a]	4.74±2.13[a]	5.07±2.09[a]
1	4.96±1.96[a]	5.03±1.95[a]	4.93±1.96[a]	4.99±1.98[a]	5.05±1.87[a]
2	4.82±1.65[a]	4.66±1.68[a]	4.95±1.85[a]	5.03±2.01[a]	5.47±2.03[a]
3	4.96±2.08[a]	4.11±1.347[a]	4.48±2.14[a]	4.54±2.16[a]	5.07±1.60[a]
4	4.58±2.32[a]	4.20±1.59[a]	4.75±2.18[a]	4.69±2.18[a]	5.59±1.51[a]
5	4.51±1.83[a]	4.74±1.73[a]	4.76±1.94[a]	4.77±1.69[a]	5.76±1.43[a]
6	4.97±1.81[a]	4.96±1.99[a]	4.99±1.71[a]	4.75±2.318[a]	5.88±1.42[a]
7	4.82±1.62[a]	5.00±1.25[a]	4.01±0.34[a]	4.64±1.75[a]	5.28±1.84[a]
8	4.99±2.08[a]	5.28±1.84[a]	4.48±1.12[a]	4.87±1.56[a]	5.62±1.58[a]

Mean standard deviation values not accompanied by the same superscript across the columns are significantly different at P< 0.05.

Key: SIP = soy-condiment powder produced in plastic; SIC = soy-condiment powder produced in calabash; PIP = locust bean-condiment powder produced in plastic; PIC = locust bean- condiment powder produced in calabash and CIC = Control condiment

Colour evaluation of soy and locust bean-condiment powders

The evaluation of colour in condiment powders were presented in Table 3. The results declared sample CIC lowest in degree of lightness (L*), redness (a*) and yellowness (b*) all through the weekly assessment of soy and locust bean-condiment powders. Comparing the condiment powders produced from plastic and calabash in week 0, condiment powders produced in plastic had highest degree of L*, b* and a*. Following results in week 1 and 3, the same trend of results in week 0 was observed. Proceeding to colour evaluation observed in week 2, the highest degree of L* occurred in locust bean-condiment powder produced in calabash (PIC), similarly PIP had highest in a* and b* but control condiment had lowest degree in L*, a* and b*.

Sensory evaluation of soy and locust bean-condiment powders

Table 4 represents sensory evaluation on soy and locust bean-condiment powders. Sample CIC scored the least value in overall acceptability with no significant difference (p<0.05).

Table 3: Colour evaluation during storage of soy and locust bean-condiment powders

Weeks	Degree of chromaticity	SIP	SIC	PIP	PIC	CIC
0	L*	37.16± 0.21[c]	32.26± 1.09[b]	40.34± 0.88[d]	37.27± 0.69[c]	24.71± 0.17[a]
	a*	5.25±0.09[d]	3.88± 0.24[c]	5.62± 0.24[e]	3.14± 0.13[b]	2.45± 0.05[a]
	b*	16.59±0.15[a]	13.59± 0.69[b]	18.40± 0.58[e]	15.63± 0.41[c]	8.35± 0.22[a]
1	L*	32.15± 1.01[b]	31.52± 0.70[b]	37.95± 0.06[d]	35.95± 2.67[c]	25.44±0.37[a]
	a*	4.79±0.24[c]	3.10± 0.14[b]	5.97± 0.05[e]	2.79± 0.32[a]	2.08± 0.10[b]
	b*	13.86±0.61[b]	12.80± 0.44[b]	17.65± 0.06[c]	14.05± 1.48[b]	9.43± 0.28[a]
2	L*	31.89± 0.10[c]	30.14± 0.01[b]	35.38± 0.17[d]	35.55± 0.08[e]	24.53±0.05[a]
	a*	4.99±0.05[d]	2.83± 0.01[c]	5.18± 0.07[e]	2.44± 0.01[a]	2.18± 0.04[b]
	b*	13.89±0.09[c]	11.79± 0.01[b]	15.75± 0.12[e]	14.22± 0.05[d]	8.63± 0.05[a]
3	L*	30.01± 0.21[c]	25.98± 1.02[b]	31.23± 0.09[d]	31.09± 0.62[d]	21.98±0.32[a]
	a*	4.40±0.06 [c]	2.12± 0.36[b]	4.88± 0.05[d]	2.08± 0.09[a]	1.76± 0.09[ab]
	b*	12.63±0.15[c]	9.19± 0.82[b]	13.58± 0.08[e]	11.87± 0.36[c]	6.90± 0.23[a]

Mean±standard deviation values not accompanied by the same superscript across the rows are significantly different at P< 0.05.

Key: SIP = soy-condiment powder produced in plastic; SIC = soy- condiment powder produced in calabash; PIP = locust bean-condiment powder produced in plastic; PIC = locust bean- condiment powder produced in calabash and CIC = Control condiment

Table 4: Sensory evaluation of soy and locust bean-condiment powders

Parameter	SIP	SIC	PIP	PIC	CIC
Colour	7.20± 1.41[b]	7.08±1.22[b]	6.52±1.50[b]	6.88±1.17 [b]	5.24±1.79[a]
Taste	6.60±1.47[a]	6.48±1.16[a]	6.76±1.30[a]	6.67±0.43[a]	6.56±0.01[a]
Aroma	6.48±1.26[ab]	6.00±1.76[a]	7.04±1.30[b]	6.64±1.28[ab]	6.64±1.73[a]
Texture	6.60±1.22[a]	6.56±1.47[a]	6.60±1.04[a]	6.28±1.06[a]	7.00±1.22[b]
Overall Acceptability	6.60±1.38[a]	6.52±1.31[a]	6.60±1.15[a]	6.76±1.20[a]	6.48±1.83[a]

Mean±standard deviation values not accompanied by the same superscript across the rows are significantly different at P< 0.05.

Key: SIP = soy-condiment powder produced in plastic; SIC = soy-condiment powder produced in calabash; PIP = locust bean-condiment powder produced in plastic; PIC = locust bean-condiment powder produced in calabash and CIC = control condiment

DISCUSSION

The method in studying moisture gained or loss of fermented soy and locust bean-condiment powders using plastic and calabash fermenting containers increased with storage duration among the samples (Figure 1). The longer the storage weeks the higher the moisture content in all samples, hence, the higher the growth of microorganisms the faster it deteriorates. It was observed that no samples lose moisture but gained throughout the studies and there was simultaneous increase in the samples. According to Omafuvbe *et al.* (2004) and Kolapo *et al.* (2007) reported simultaneous increase of iru condiment. This inferred why salt should be added to condiment functioning as preservatives because salt absorbs moisture, inhibit growth of microorganism thereby, prolonging its shelf life. This statement was justified by (Ojewunmi *et al.*, 2018). Locust bean-condiment powder produced in plastic gain moisture more than locust bean-condiment produced in calabash as the statement negates soy-condiment powder produced in plastic and calabash. Moisture gain in the final week of storage (week 8) especially African locust bean-condiment powder produced in plastic could be attributed to high fat content in the sample products. This statement concurs with Food and Health Survey (2017).

Fermentation led to increase in the microbial load of the fermented products. The counts in all samples concur with total viable count reported on the fermentation of locust bean at 72 h (Atalabi, 1984). There was no coliform count recorded in the samples except control condiment (0.73 $\log_{10}$ cfu/mL) owing to poor handling, unhygienic practice and poor environmental cleanliness. Furthermore, no traces of fungal growth was recorded in the entire sample which might be due to low moisture content of the samples and hygiene practiced before, during and after processing. It was stated in earlier study that no fungi growth was recorded during and after fermentation process of ogiri-isi and ALB-iru (Odunfa, 1985; Barber and Achinewhu, 1992; Sanni *et al.*, 2002).

Total viable count as the name implies, is a count of the total number of living bacteria in a sample. It reflects the conditions subjected the food produced, stored or abused with experience, which in turns, predict the shelf life or keeping quality of the product. The spoilage of food product could be imminent when total viable count reaches 10-100 million per gram of the products. The control condiment had highest total viable count during storage period of microbial examination which could probably linked to high contamination of raw material, poor handling, processing and utensils used in the production (Table 2). Bacteria population of samples significantly differ ($p<0.05$) during the storage in week 8. The Total viable count ranged from 4.93 to

5.05 $\log_{10}$ cfu/mL for the first week of storage with the control condiment having the highest (5.05 $\log_{10}$ cfu/mL). Nevertheless, the control condiment had highest overall value of total viable count ($\log_{10}$ cfu/mL) throughout the 8-week of samples storage. The microbial load of soy and locust bean-condiment powders observed in this study were lower compared to 7.40-7.81 and 7.45-7.75 reported for African locust and soy beans condiment respectively (Omodara and Olowomofe, 2015).

Colour evaluation is an important part of safety and marketability in the food industry. Numerous studies have shown that visual acceptance is the first thing consumers rely on when making choices in food. Food color is so influential it can even change the way consumers perceive taste and quality in foods. Among the samples, there was a significant difference ($p<0.05$) in the degree of lightness (L*), redness **(a*)** and yellowness (b*) (Table 3). The samples with highest values of the instrumental color parameters indicated that the products had strong tendency to yellowness, slight redness with good luminosity as well as some degree of purification and separation from some heterogeneous materials. The sample PIP with yellow colour is attributed to the presence of carotenoids in African locust bean compared to soybean condiment powder. According to Costal *et al.* (2017), reported values in degree of L* (68.20) and b* (41.55) higher than results obtained under this study and degree of redness (a*) obtained falls within the range of results reported by earlier scientist (4.36).

The texture of samples CIC scored optimum value, PIP had highest in aroma and SIP was ranked highest in colour. The sample PIC was generally accepted among all samples. There is no significant difference ($p<0.05$). Generally, panelist preferred the produced condiment powders to locust bean-condiment purchased in the local markets.

CONCLUSION

Soy and locust bean-condiment powders were processed using plastic and calabash fermenting containers. Assessments were carried out on the storage stability of moisture either gained or lose, microbial counts and alteration in colours as well as sensory property. The condiments powder gained moisture content throughout the 8 weeks of storage studies fermented in both plastic and calabash containers. African locust bean-condiment powder produced from plastic had pleasing colour evaluation compared to soy-condiment produced with the plastic container. Condiment powders produced from calabash and plastic containers had lowest microbial and zero coliform count during storage compared to control condiment. Furthermore, panelist liked processed condiment powder compared to control condiment. However, this study showed that soy and locust bean-condiment could be processed conveniently using plastic as fermenting containers in our various homes without altering the chromaticity and sensory property. Plastic container can therefore be used as replacement for calabash container; which is gradually going to extinction.

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