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Effects of Quantity of Salt and Drying on the Quality of Locust Beans

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Abstract: This research work investigated effects of quantity of salt and drying on the quality of 80 g sample of locust beans. Three categories of sample i.e., Non-salted, 5 g salted and 10 g salted, were analysed using the Direct Sunlight method of drying. After drying for 5 days, proximate and microbial analysis showed that the samples still retain most of their nutritional components and therefore fit for human consumption. Investigation also showed that salted sample is more nutritional than non salted sample as it contains 67.65% of protein as against 66.82% protein in the non-salted sample. After 5 days of drying, the non-salted sample had a microbial load of 1.02×10^{7} cfu g^{-1}as against the 1.42×10^{5} cfu g^{-1} of the salted sample. The drying rate analysis also revealed that the non-salted sample has the fastest drying rate followed by 5 g-salted sample, with the 10 g salted sample having the least drying rate. At the end of the 3rd day of drying, the non-salted sample weighed 32 g; the 5 g sample weighed 36 g while, the10 g sample weighed 44 g.

Key words: Locust Bean, fermentation, salt, drying, solar, sample

INTRODUCTION

Locust Bean (*Parkia biglobosa*) belongs to the leguminous group used in many food dishes in West Africa. It is gotten from the Locust bean tree that grows in the savannah area of West Africa. The tree has feathery doubly divided leaves, red flower and long narrow pods and it has black seed. It contains about 38% protein, 31 fat and 23.6% carbohydrate when it is moisture free and 30% protein, 15% fat, 49% carbohydrate when fermented (Campbel-Patt, 1980). It is known as 'Iru' in Yoruba language, south western Nigeria 'Kipaluga' among the 'Kusasis' and 'Dagommbas' of Northern Ghana, 'Kinda' in Sieria Leone and 'Netetu' or 'Soumbia' in Gambia and Burkina Faso (Diawara, 2000).

Locust beans are medicinal and it is used as mouthwash to relieve toothaches. The beans husk (seed coats) is used with indigo dye to improve the luster of fabric while the tree bark yields red tannin for dying leather. It is normally, used as a soup or stews flavouring materials and constitutes an essential ingredient in preparation of local soup or stew (Odunfa, 1983).

Preparation of Locust bean starts with boiling for 12 h and further soaking in boiling water for another 12 h, preferably overnight. Excess water was drained off and the seeds were dehulled by marching the seeds with the feet in a large wooden mortal. Further removal of the seed coat was achieved by rubbing the cotyledons between the palms of the hand and thereafter washed with water. The cotyledon was again cooked for another 6 h, the hot boil water was drained off and the cotyledon were then spread into calabash trays, covered with wooden trays, wrapped with jute bags and fermented for 3-4 days to produce iru (http://www.pjbs.org/pjnonline/fin). The long boiling period can however be reduced by using a pressure cooker to boil the locust bean.

A softening agent called 'kuru' containing sunflower seed and 'kuru' may be added during the second boiling to aid softening of the cotyledons. After boiling, the seeds were drained and spread in calabash trays in layer of about 4 cm depth. About 2 or 3 trays are stacked together and wrapped in many layer in jute sacks and coarse cotton cloth to provide warmth and a humid atmosphere. The seeds ferment for about 36 h (Adams, 1990). Ajayi (1999) reported that Locust bean fermentation is solid substrate fermentation; this is unlike most other fermentation of food in West Africa, which is usually in liquid menstrum, the temperature of 25-30°C to 45-50°C. The fermentation temperature is 37.5°C after 24 h and 39°C after 36 h, when a starter was used. During the 3 days of fermentation, the cotyledons change in colour from light brown to dark brown and become softer (Campbel-Patt, 1980; Steinkraus, 1998). The results of the chemical analyses indicate that fermentation resulted in protein

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enrichment of the fermented locust bean. Fermentation also imparts a characteristic flavour and odour to the beans (http://www.freepatentsonline.com/login.html). Fermented beans have a greyish sticky mucilage covering and a strong ammoniac smell. This peculiar odour and flavour enhance its taste in traditional soup used to eat root and tuber diets. Salt is added to preserve the bean (Eka, 1980).

The locust bean also known as carob has several uses in food and medicine. It is rich in insoluble fibre. Like other sources of fibre, it has shown some promise for improving cholesterol profile. In a small double-blind, placebo-controlled study, use of carob powder at a dose of 15 g daily significantly reduced levels of LDL (bad) cholesterol as compared to placebo. Carob also contains tannins, astringent substances found in many plants. Foods rich in tannins are often recommended for treatment of diarrhea. A double-blind clinical trial of 41 infants with diarrhea found that carob powder (at a dose of 1 g/kg/day) significantly speeded resolution of diarrhea as compared to placebo. The portion of carob that is made into locust bean gum contains soluble fibre in the galactomannan family. Like other forms of soluble fibre, it has shown potential benefit for enhancing weight loss and controlling blood sugar levels (http://wiki.answers.com).

This research offers the best way to preserve already prepared locust bean and to still retain their nutrients to some reasonable extent. Microbial and Proximate analyses were also carried out on the locust bean.

MATERIALS AND METHODS

African locust bean samples were taken from the Kings market, in Ado Ekiti metropolis, Ekiti State, Nigeria. An all-glass apparatus were used, which were washed with detergent, rinsed and thoroughly sterilized in the oven at 160°C for 3 h. The non absorbent cotton wool wrapped with aluminium foil and other media used such as nutrient agar, nutrient broth and the formulated ones were sterilized in an autoclave at 121°C for 15 min.

The first stage of the research is the Drying stage. Three samples of 80 g locust bean were used here, comprising non-salted locust bean, locust bean with 5 g of salt and locust bean with 10 g of salt. The 3 samples were spread on a tray, placed on the digital weigh balance, weighed and their masses recorded. The 3 samples were then exposed to Direct Sunlight for 6 h (10.00 am - 4.00 pm, Nigeria time). The mass (M), Dry bulb temperature (T_{db}), Wet bulb temperature (T_{wb}) and the solar intensity (I) were recorded at an interval of 30 min. The drying was done for 3 consecutive days.

The second stage involves Microbial Load analysis (Serial Dilution).

Preparation of nutrient agar: Nutrient agar was prepared by weighing 1 g of the dehydrated power into 100 mL of diluted water in a conical flask. The flask was plug with cotton wool wrapped with foil paper. The medium was heated to dissolve the agar and sterilized at 121°C for minutes in autoclaving machine.

Serial dilution preparation: One gram of the locust bean sample was weighed into 9 mL of sterilized water in Mac cartney bottle and mixed thoroughly by shaking. The suspension was then diluted 6 fold serially to 10^{-6}. The 1 mL of the last diluted tube was pipetted into a sterile petridish. Molten sterile nutrient agar, which was cooled to 45°C, was poured into the petridish. Then disperse inoculum in the medium, allowed to solidify on the bench, inverted and incubated at 38°C for 24 h. The cultural characteristics of the colonies were observed and recorded.

$$\begin{aligned} N &= X \text{ size of inoculum} \times 1/\text{Dil. Ratio} \\ &= 100 \times 1 \times 1\ 10^{-5} \\ &= 1 \times 10^{7}\ \text{CFU gm}^{-1} \text{ of samples} \end{aligned}$$

The 3rd stage in the research is the Proximate Analysis.

Moisture content determination: Clean oven-dried petri dishes were weighed (X_1) on the weigh balance. Samples were added and weighed (X_2). The dishes and the contents were transferred into a thermosetting oven at 105°C for 4 h, cooled in a dessicator. The samples were further dried in the oven to constant weight (X_3).

The percentage moisture content was determined as shown below.

$$\text{Moisture content (\%)} = \frac{X_2 - X_3}{\text{Weight of the sample}} \times 100$$

Determination of ash content: The ash of a biological material is an analytical term for the inorganic residue that remains after the organic matter has burnt off. Empty crucible was heated in a muffle furnace for 15 min at 350°C and cooled inside desiccator for 1 h at room temperature and weighed (W_1) on a weigh balance. About 1 g of the sample was weighed qualitatively into the crucible (W_2). The crucible containing the sample was transferred into the muffle furnace. The temperature was slowly increased from 200-500°C to prevent

incomplete ashing. The ashing continued until the sample was cooled in desiccator and weighed W_3.

$$\text{Ash } (\%) = \frac{W_3 - W_2}{W_1} \times 100$$

Fat content determination: Cooled oven-dried filter paper was weighed (Y_1) on a weighing balance. About 1 g of the samples were weighed on the filter paper and carefully wrapped and weighed (Y_2). A fat free thread was used to tie the wrapped filter paper containing the sample and weighed as (Y_3), this was inserted into the extraction chamber of the soxhlet apparatus and extraction under reflux with petroleum for 6 h. The wrapped filter paper was removed and oven-dried at 60°C to a constant weight (Y_4).

$$\text{Fat } (\%) = \frac{Y_3 - Y_4}{Y_2 - Y_1} \times 100$$

Crude fibre determination: About 1 g (Z_1) of the defatted sample was weighed into a pre-weighed 500 mL conical flask. About 200 mL of hot 1.25% H_2SO_4 was added and gently boiled for 30 min so as to maintain a constant volume of the acid and to prevent any particle of the sample from being escape during boiling.

The mixture was filtered through a Poplin cloth in a bucher funnel. The left over was scrapped with spatula into another conical flask and 200 mL of boiling 1.2% NaOH solution was added and boiled gently for 30 min, filtered and the residue fibre was washed thrice with hot distilled water, twice with ethanol and thrice with ether.

The fibre was allowed to drain and then scrapped into a pre-weighed crucible (Z_2). The crucible and its content was dried in an oven at 105°C, cooled in the desiccator and weighed at (Z_3)

$$\text{Crude fibre } (\%) = \frac{Z_3 - Z_2}{Z_1} \times 100$$

Determination of protein content: About 1 g of the sample was weighed into 500 mL Kjeldal flask. One kjeldahal catalyst tablet was added. The mixture was digested on an electric heater in the fume cupboard for several hours until a colourless solution was obtained. The flask was diluted to 100 mL with distilled water.

$$H_2SO_4 + 2NH_3 \rightarrow (NH_4)_2SO_4$$

Distillation stage: About 20 mL of 2% boric acid in 100 mL conical (receiving) flask was added 3 drops of screened methyl-red indicator. The receiving flask was placed so that the tip of condenser tube was below the surface of the boric acid trap the ammonia vapour. About 10 mL of the digested sample solution was pipetted into distillation apparatus (Markham-distiller). About 10 mL of 40% NaOH solution was added and the colour changed from pink to blue indicating that enough alkaline has being added. All joint of distillation column were tightly closed and about 50 mL of the distilled water was collected into the receiving flask.

$$(NH_4)_2SO_4 + 2NaOH\ 2 \rightarrow Na_2SO_4 + NH_3 + 2H_2O$$

Titration stage: The distilled water was titrated with 0.10M of HCl. A blank was prepared following the same steps and using the same reagent but without the sample.

$$NH_3 + HCl \rightarrow NH_4Cl$$

$$\text{Nitrogen } (\%) = \text{Sample Titre-Blank Titre} \times 0.014 \times 0.1 \times 100$$

$$\text{Nitrogen } (\%) = \frac{(ST - BT) \times 0.014 \times 0.1 \times 100 \times 10\%}{\text{Weight used}}$$

$$\text{Crude protein } (\%) = \%\ \text{Nitrogen} \times 6.25$$

RESULTS AND DISCUSSION

Table 1 (a-c) showed the result of the drying analysis for the 3 categories of samples, i.e non-salted, 5 g salted and 10 g salted samples. The experiment was carried out with 80 g of locust bean sample. There was a reduction in mass of the sample as drying progressed as shown in Table 1 (a-c). After 3 days of drying, the mass of the sample recorded were 32, 36 and 44 g for the non salted, 5 g salted and the 10 g salted samples, respectively.

During the 3 days of the experiment, the dry bulb temperature of the atmosphere varied between 30 and 40°C while the wet bulb temperature varied between 25 and 30°C. The solar intensity (I) varied between 35 and 226 W m^{-2}.

Table 2 and 3, respectively showed the results of proximate analysis of non-salted and salted samples. The tables showed that the percentages of protein, fat and carbohydrate increased as drying progressed while the moisture content and the percentage of ash reduced. The percentage of fibre however, remained constant. After 5 days of drying, salted sample however, contained more protein, carbohydrate, fat, fibre, and ash than the non-

Table 1(a): Drying analysis of locust bean . Day 1

Time (h)	Non-salted	5 g salt	10 g salt	T_{db} (°C)	T_{wb} (°C)	I (Wm^{-2})
10.00	80	80	80	30	25	100
10.30	76.5	76	77.5	31	25	117
11.00	72	71	71	32	25	77
11.30	64.5	64	65.5	36	25	125
12.00	57	57.5	62	38	27	135
12.30	50	52	56.5	39	26	145
13.00	45	48.5	54.5	38	25	130
13.30	41.5	45	52.5	36	25	135
14.00	39.5	43	51.5	38	25	175
14.30	37.5	41.5	50.5	40	25	202
15.00	37	40.5	49.5	36	28	179
15.30	36.5	40	49	37	25	78
16.00	36	39.5	48.5	37	25	120

Table 1(b): Drying analysis of locust bean. Day 2

Time (h)	Non-salted	5 g salt	10 g salt	T_{db} (°C)	T_{wb} (°C)	I ($W m^{-2}$)
10.00	35.5	39	48	30	27	35
10.30	35.5	39	48	31	27	161
11.00	35	38.5	47.5	33	27	142
11.30	35	38.5	47.5	34	27	149
12.00	34.5	38	47	36	27	135
12.30	34	38	47	38	27	159
13.00	33.5	37.5	46.5	34	29	221
13.30	33.5	37.5	46.5	32	28	226
14.00	33.5	37.5	46	38	27	128
14.30	33	37	46	37	27	174
15.00	33	37	45.5	38	27	179
15.30	33	37	45.5	37	27	128
16.00	33	37	45	32	27	111

Table 1(c): Drying analysis of locust bean. Day 3

Time (h)	Non-salted	5 g salt	10 g salt	T_{db} (°C)	T_{wb} (°C)	I (Wm^{-2})
10.00	33	37	45	30	28	131
10.30	33	37	45	32	28	142
11.00	33	37	45	34	28	138
11.30	33	36.5	44.5	35	28	135
12.00	32.5	36.5	44.5	38	28	109
12.30	32.5	36.5	44.5	32	30	75
13.00	32.5	36.5	44.5	34	29	112
13.30	32	36	44	36	28	142
14.00	32	36	44	37	28	139
14.30	32	36	44	35	28	178
15.00	32	36	44	32	28	191
15.30	32	36	44	33	29	203
16.00	32	36	44	34	28	201

T_{db} = Dry bulb temperature (°C); T_{wb}= Wet bulb temperature (°C); I = Solar intensity ($W m^{-2}$)

Table 2: Proximate analysis for non-salted sample

Days	Moisture (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Fibre (%)	Ash (%)
Fresh	38.66	43.7	7.34	3.3	2.2	4.8
Day 1	34.2	48.24	9	2.6	2.2	3.76
Day 2	24.7	55.04	13.1	2.1	2.2	2.86
Day 3	20.1	59.98	14.32	1.3	2.2	2.1
Day 4	14	64.3	17	0.75	2.2	1.75
Day 5	10.42	66.82	19.4	0.32	2.2	0.84

alted sample. The proximate analysis showed that drying did not make locust bean unfit for consumption as the sample retained the nutrients even after 5 days of drying.

Table 3: Proximate analysis for salted sample

Days	Moisture (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Fibre (%)	Ash (%)
Fresh	39	44.06	8.2	3.92	2.51	2.31
Day 1	35.42	48.21	8.14	3.6	2.51	2.12
Day 2	29.05	53.84	9.28	3.21	2.51	2.11
Day 3	20.1	60.55	12.54	2.44	2.51	1.86
Day 4	15.35	64.64	14.21	1.87	2.51	1.42
Day 5	11.16	67.65	16.44	1.32	2.51	0.92

Table 4: Microbial Load (cfu/g) analysis for both salted and non-salted samples

Sample /Day	Fresh	Day 1	Day 2	Day 3	Day 4	Day 5
Non-salted locust beans	1.5×10^{7}	1.4×10^{7}	1.3×10^{7}	1.91×10^{7}	1.11×10^{7}	1.06×10^{7}
Salted locust bean	4.32×10^{5}	4.17×10^{5}	3.5×10^{5}	3.18×10^{5}	1.78×10^{5}	1.42×10^{5}

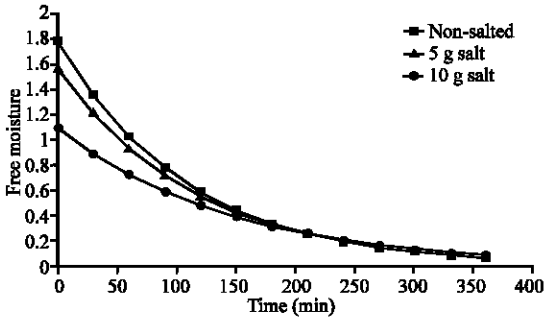

Fig. 1: The graph of Free moisture content against time (min) for day 1

Table 4 showed the microbial load, which is the amount of micro organisms present in a given sample, in the fresh sample and after each day of drying for both the non-salted and salted samples. It was observed that as drying progressed, the microbial load is also being reduced. This indicates that some of the micro organisms originally present in the fresh sample were dying due to lack of adequate moisture to support their continued existence. The salted sample had lower microbial load because of the presence of salt which is a known and tested preservative. The reduction of the microbial load improved the appearance, taste, odour, shelf life e.t.c., of the samples.

Figure 1, which is a plot of the free moisture against time for day 1, showed that at the beginning of the experiments, non-salted sample had the greatest quantity of moisture followed by the 5 g salted sample and the 10 g salted sample in that order. At the send of the 1st day of drying, both the non-salted and the 5 g salted samples had the same amount of moisture with the 10 g salted sample having a slightly higher moisture. The free moisture analysis of the samples for day 2 revealed that

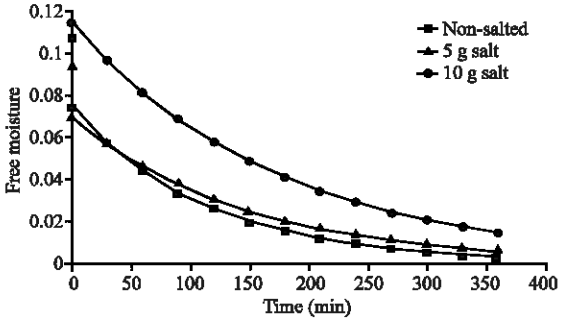

Fig. 2 The graph of free moisture against time (min) for day 2

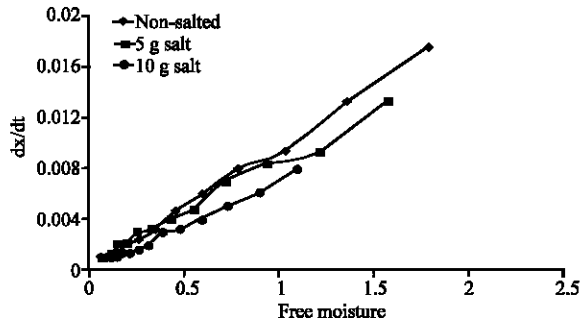

Fig. 3: The graph of drying rate against free moisture for day 1

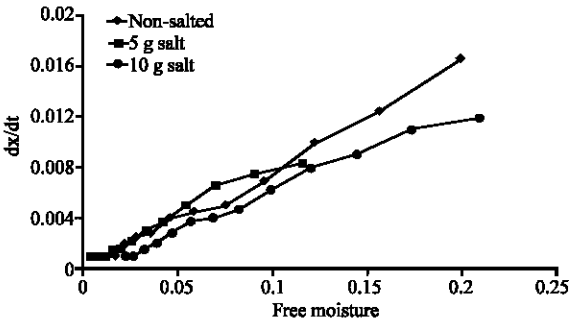

Fig. 4: The graph of drying rate against free moisture for day 2

the 10 g salted sample had the most moisture, followed by the 5 g salted sample and the non-salted sample in that order as shown in Fig. 2, which depicts the plot of free moisture against time for day 2. Figure 3 and 4 showed the graph of drying rate against free moisture for days 1 and 2, respectively. The drying rate analysis revealed that the non-salted sample had the greatest drying rate, followed by the 5 g salted sample, with the 10 g salted sample having the least drying rate as shown in Fig. 3 and 4.

The drying rate analysis for day 3 was not carried out since there is no significant difference between it and day 2.

CONCLUSION

This research has been able to establish that the quantity of salt and drying have effects on the quality of locust bean. Since the harvest of locust bean is seasonal, the need for preservation cannot be over emphasized, this work has presented the optimum conditions for locust bean preservation.

- Five g of salt is enough to preserve and maintain 80 g of locust bean nutritionally.
- Three days of drying is adequate to fully preserve 80 g of locust bean.
- Non-salted locust bean has more microbial load than salted locust bean.
- Non-salted sample dry faster than salted sample.
- Salted sample is more nutritional than non-salted sample.

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