DOI: 10.36566/ijhsrd/Vol6.Iss2/226
https://ijhsrd.com/index.php/ijhsrd

Indonesian Journal Of Health Sciences Research and Development
e- ISSN: 2715-4718

Research Article

PHYSICOCHEMICAL AND SENSORY PROPERTIES OF FERMENTED PROSOPIS AFRICANA SEEDS

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ABSTRACT

Background: Fermented Prosopis Africana seeds called Okpehe by the Idoma people of Benue State, Nigeria are a commonly prepared food Condiment added to food so as to improve its aroma and taste

Methods: It was produced in the laboratory using Spontaneous method and preserved for twelve days using different concentration of Clove and Ginger extracts (1.6%, 2.4%, and 3.2%). The aim of the study was to evaluate physicochemical and sensory parameters of fermented Prosopis Africana seeds during preservation.

Results: A total of 100 responses were obtained, out of which 50% of respondents opted for offline purchase of medicines from nearby pharmacies. In conclusion, it was observed that the majority of the population prefers the offline mode of purchase when it comes to the purchase of medicines and other healthcare products, though there are various major advancements in technology and variety of internet services and easy availability of e-medicines.

Conclusion: It can be inferred from this study that the extracts of spices represent an alternative source of natural antimicrobial substances for use in food systems to prevent the growth of food borne microorganisms and extend the shelf-life of the processed food.

Keywords: Conception, E-pharmacy, Health-conscious, Technology

INTRODUCTION

Prosopis africana also known as iron tree is the only species of Prosopis that is indigenous to tropical Africa. Its tree could be between 4-20m long. This tree is characterized by a deep, fast-growing tap root. Prosopis africana (PA) is mostly found growing in the savanna regions of western Africa.(1)

Prosopis africana are pod bearing trees, which thrive well in the savannah region of Nigeria. The fruit of Prosopis africana has a thick-walled glossy fruit with seeds each of about 1 to 2cm long. Most species are tropical and include trees, woody vines and herbaceous plants, Prosopis africana is one of the lesser known leguminous seed crops used as food condiment in Nigeria (Asoiro and Ohagwu, 2017). Indigenous fermented condiments were very important in Nigeria since the majority of the people can no longer afford the high cost of animal proteins. Traditional condiments were not attained worldwide commercial status due to the short shelf life and objectionable odour.(2) Fermented condiments were often considered as food for the poor. Production of these condiments were mainly by traditional fermentation carried out in people's houses using pot made from clay.(3)

Legumes go through several primary processes before they are used in different food preparations. Some legumes are processed to detoxify the anti-nutritional factors, increase palatability and improve bioavailability of the nutrient. Among the processes are: soaking, dehulling, drying and size reduction or milling. The purpose of the study is to determine the best preservative method for Okpehe using different plants extract, determine physicochemical parameters and sensory properties of fermented Prosopis africana seeds, data obtain from this study will provide more information to the nutritional value of the condiment.

METHOD

Study design

Preparation of Okpehe Samples

One kilogram (1kg) of dried seeds of Prosopis africana seeds were purchased from Brigade Market in Kano, Nigeria. Okpehe was prepared in the laboratory using autoclave as described by Balogun and Oyeyiola, (2012). Eight hundred gram (800g) of Prosopis africana seeds were boiled at 1210C for 2 hours in an autoclave and later dehulled. The cotyledons were separated from the coats and later rinsed with sterile water and boiled again in an autoclave for about 30minutes to soften the cotyledons. The cotyledons were later drained through a sterile sieve and cooled to about 350C before wrapping in banana leaves already sterilized with alcohol. The wrapped cotyledons were incubated in an incubating unit for three days to produce the usual fermented mash of Okpehe.(4) The fermenting Prosopis africana seeds was removed for analysis at selected times of fermentation, 0, 24, 48 and 72 hours (Figure 1)

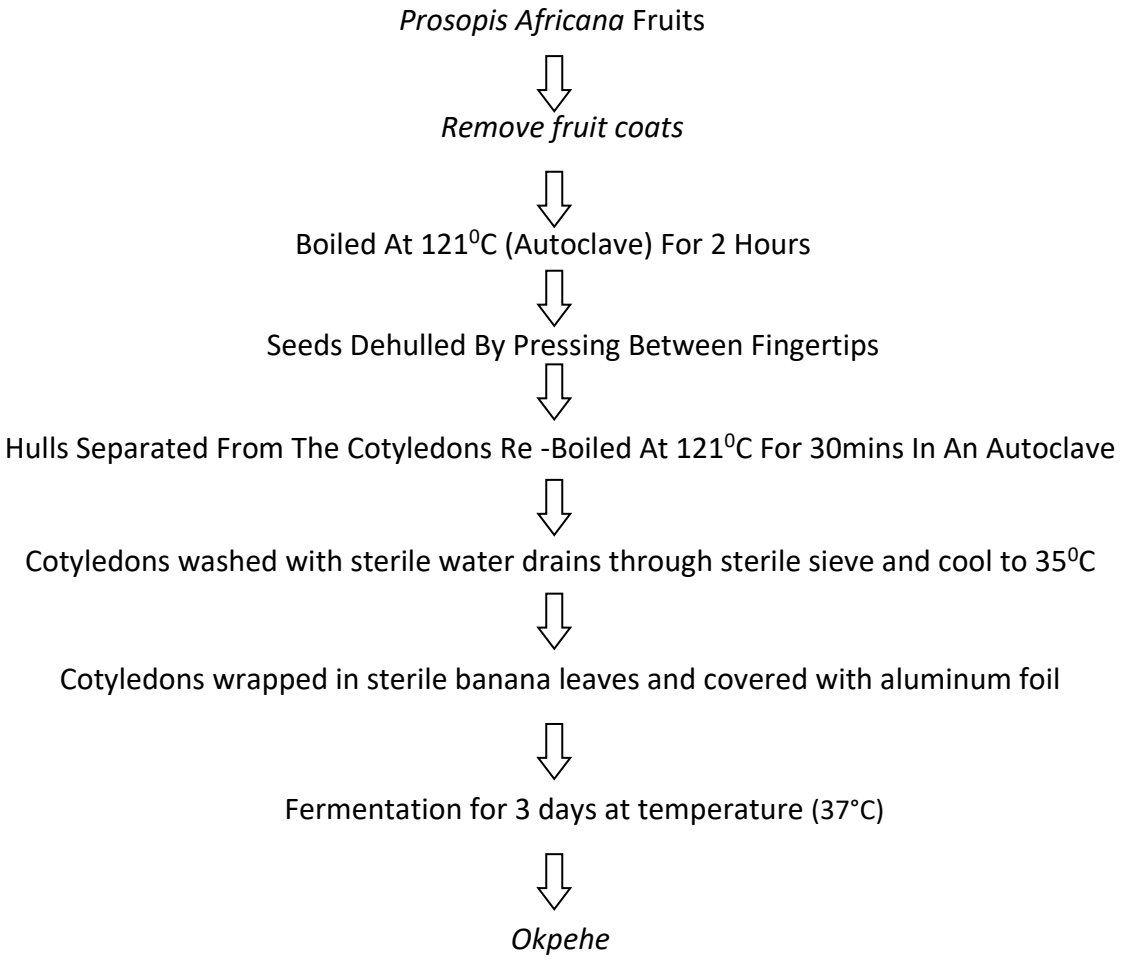

Figure 1: Flow Chart for laboratory preparation of Okpehe

Determination of Physico-chemical Parameters of laboratory fermentation of fermented *Prosopis africana* seeds

Determination of pH of fermented *Prosopis africana* seeds

A pH meter (model Denwer 20) was used for this purpose. It was used to measure the acidity and alkalinity of the *Okpehe* samples. It was first standardized using standard buffer solution of pH 4 and pH 7. The electrode was rinsed with distilled water and immersed into the samples. Five grams of the different samples was ground thoroughly in a mortar. This was suspended in 100ml of distilled water. The pH of the suspension was measured using pH meter (model Denwer 20).

Determination of Temperature of fermented *Prosopis africana* seeds

The temperature was determined by inserting a probe sterile thermometer (wiped with alcohol) into each of the samples on each day of fermentation. The mercury-in-glass thermometer was used. Readings were taken and recorded in duplicates.

Preservation of *Okpehe*

Prepared *Okpehe* was treated with different concentrations of plants extracts and stored for 12 days with readings taken at interval of 3 days.

Preparation of Plants Extracts (ginger and Clove)

Ginger rhizomes and Clove were washed, with distilled water in a clean basin to remove any soil adhering on the surface; this also softened the outer dry skin for easier peeling. After rinsing with distilled water, the washed ginger and clove were peeled off with a sterile knife and then sliced into cutlets and dried using an oven-dried at 55ºC for 24 hours. The dried spices were grounded to a fine powder in a mill and sieved. Ten gram (10 g) each of the powdered ginger and clove were extracted with 100ml of ethanol overnight at room temperature. The extract were filtered to remove residue and then evaporated in a water bath at 40ºC. The extracts obtained after evaporation of ethanol were used as a natural antioxidant (Zia-Ur-Rehman *et al.*, 2003).

From the ten (10 %) concentration of each of the extracts, other concentration were measured (1.6%, 2.4%, and 3.2%) which correspond to 1.6ml, 2.4ml and 3.2ml concentration of extracts which were applied in to the 10g sample of *Okpehe* condiment. 0% extracts served as control. For each treatment sample, three concentrations of plants extracts were prepared with control making a total of ten treatments. All samples of each treatment were prepared in triplicate and stored at ambient temperature (30±2°C) for twelve days to determination of the combined effect of mixed extracts on *Okpehe* condiment Concentrations prepared above were halved and combined together to produce mixed extracts of ginger and clove of 1.6%, 2.4%, and 3.2% which correspond to 1.6ml, 2.4ml and 3.2ml concentrations of extracts. Suspensions were added to 10g *Okpehe* condiment.

Sensory Evaluation of *Okpehe* condiment

The different treatments of *Okpehe* sample produced were made in to Yajin *Okpehe* using measured amounts of some other spices (clove 1g, ground dry pepper 1g, *Okpehe* 10g, salt 0.04g), Judges were offered clean water to rinse their mouths in between servings of different *Okpehe* treatments. Ten panelists within 18-30 years of age were used to evaluate *Okpehe* samples treated with different concentrations of ginger, clove and their combinations (1.6%, 2.4%, and 3.2%). The samples were evaluated for appearance, colour, odour, and overall acceptability. The extent of differences among treatment samples for each sensory attribute was measured using a 9-point Hedonic scale where 9 represents ‘extremely like’ and 1 represents ‘extremely dislike. Data obtained from sensory evaluation parameters were subjected to one way analysis of variance (ANOVA).

RESULTS

Physico-chemical Parameters of Fermented *Prosopis africana* seeds

The fermentation of *Prosopis africana* seeds to produce *Okpehe* was accompanied by an increase in pH and temperature from the beginning to the end of fermentation. At the beginning of fermentation (zero hour), the pH of 6.47 was recorded while pH of 8.37 recorded after 72 hours of fermentation (Figure 1).The temperature recorded at the beginning of fermentation (zero hour) was 35.27^{o}C and at the end of 72 hours of fermentation was 39.90^{0}C (Figure 1).

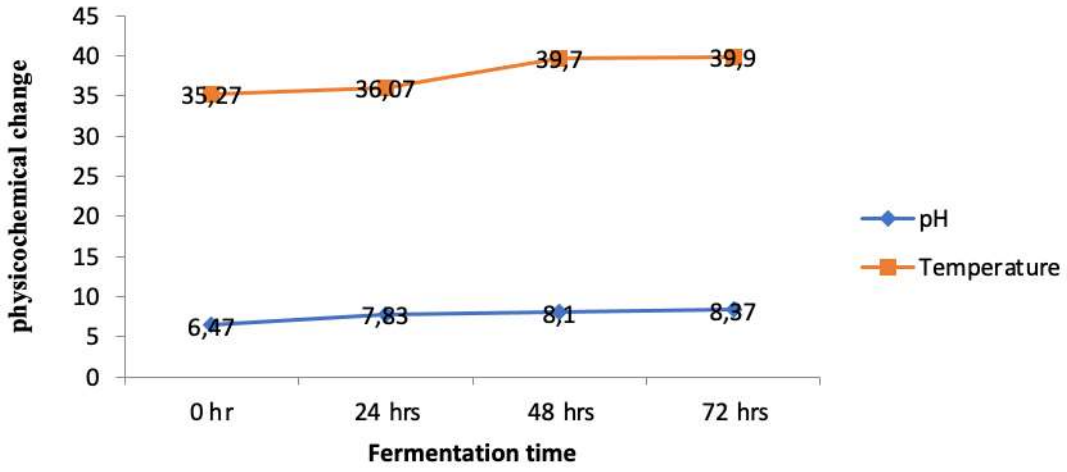

Figure 1: Changes in pH and Temperature during fermentation of *Prosopis africana* seeds

Sensory properties of the treated samples of *Okpehe* under preservation using plants extracts of ginger, clove and their combination at different concentrations

Okpehe samples preserved with ginger and clove with concentration of 2.4% and 3.2% of the extracts were highly rated by the Panelists in term of appearance, colour, odour, and general acceptability for a period of twelve days, sample were taken after three days. On the zero day and day three of storage, all the treatments samples were rated 100% like by the panelists. On the day six, treatment A (control) with mean scores (2.1±0.88) was rated 100% dislike, while treatment B with mean scores (5.8±1.32) was rated 20% dislike and treatment C with mean scores (6.2 ±1.03) was rated 10% dislike by the panelists while other treatments were rated 100% like by the panelists. On the day nine of storage treatment A, B, C and D was rated 100%, 70%, 60% and 50% dislike respectively while treatment E, F, G ,H, I, J were rated 100% like by the panelist as presented in (Table 1-5) . On the day twelve, treatment A, B, C, D, E, F, G, H were rated 100%, 80%, 40%, 30%, 20%, 20%, 20% and 20%, dislike respectively while treatment I, and J were 100% like by the panelists (Table

5). *Okpehe* samples treated with clove extracts only at all concentration had low in percentage dislike by the panelists compare to ginger treatment only. Low percentage dislike by the panelists is an indication that clove alone can be used to preserve *Okpehe* condiments perfectly without deterioration. Similarly, the hedonic scale responses of dislike for control *Okpehe* condiment (no treatment) of 100% clearly indicated their general unacceptability to the products by the panelists. Generally *Okpehe* samples treated with concentrations of ginger and clove alone had similar trends in appearance and aroma however clove alone is active in preservation than ginger alone because is more preferable by the panelists, *Okpehe* samples treated with ginger and clove concentrations beings the most desirable in appearance and aroma followed by *Okpehe* treated with clove alone. In addition all the Yajin *Okpehe* formulations were highly acceptable. Distribution of Responses on HEDONIC SCALE for various treatments of fermented *Prosopis africana* seeds on the 12th day of storage were presented in Table 1- 5.

Table 1: Distribution of Responses on HEDONIC SCALE for various treatments of fermented *Prosopis africana* seeds on the 0th day of storage

Option	Scale	A	B	C	D	E	F	G	H	I	J
Like extremely	9	1	3	7	5	4	6	7	10	10	10
Like very much	8	6	7	3	5	6	4	3	0	0	0
Like moderately	7	2	0	0	0	0	0	0	0	0	0
Like slightly	6	1	0	0	0	0	0	0	0	0	0
Neither like nor dislike	5	0	0	0	0	0	0	0	0	0	0
Dislike slightly	4	0	0	0	0	0	0	0	0	0	0
Dislike moderately	3	0	0	0	0	0	0	0	0	0	0
Dislike very much	2	0	0	0	0	0	0	0	0	0	0
Dislike extremely	1	0	0	0	0	0	0	0	0	0	0
Mean ± Standard error		7.7 ±0.26	8.3 ±0.15	8.7 ±0.15	8.5 ±0.17	8.6 ±0.17	8.6 ±0.17	8.7 ±0.15	9.0 ±0.00	9.0 ±0.00	9.0 ±0.00
Total responses		10	10	10	10	10	10	10	10	10	10
% Dislike		0	0	0	0	0	0	0	0	0	0
Comments	Good aroma and taste										
Number of days taken before spoilage		4	6	7	8	10	11	11	11	>12days	

Key: A = Control, B = 1.6% ginger extract treated, C = 2.4% ginger extract treated, D = 3.2% ginger extract treated, E = 1.6% Clove extract treated, F = 2.4% Clove, G = 3.2% Clove extract treated, H = 1.6% ginger + Clove extract treated, I = 2.4% ginger + Clove extract treated, J = 3.2% ginger + Clove extract treated.

Table 2: Distribution of Responses on HEDONIC SCALE for various treatments of fermented *Prosopis africana* seeds on the 3rd day of storage

Option	Scale	A	B	C	D	E	F	G	H	I	J
Like extremely	9	0	2	4	5	5	3	3	7	10	10
Like very much	8	5	7	5	5	3	6	6	3	0	0
Like moderately	7	5	1	1	0	2	1	1	0	0	0
Like slightly	6	0	0	0	0	0	0	0	0	0	0
Neither like nor dislike	5	0	0	0	0	0	0	0	0	0	0
Dislike slightly	4	0	0	0	0	0	0	0	0	0	0
Dislike moderately	3	0	0	0	0	0	0	0	0	0	0
Dislike very much	2	0	0	0	0	0	0	0	0	0	0
Dislike extremely	1	0	0	0	0	0	0	0	0	0	0
Mean ± Standard error		7.5 ±0.17	8.1 ±0.18	8.3 ±022	8.5 ±0.17	8.3 ± 0.26	8.0 ±0.30	8.2 ± 0.20	8.7 ± 0.15	9.0 ± 0.00	9.0 ± 0.00
Total responses		10	10	10	10	10	10	10	10	10	10
% Dislike		0	0	0	0	0	0	0	0	0	0
Comments	Good taste with aroma										
Number of days taken before spoilage		4	6	7	8	10	11	11	11	>12days	

Key: A = Control, B = 1.6% ginger extract treated, C = 2.4% ginger extract treated, D = 3.2% ginger extract treated, E = 1.6% Clove extract treated, F = 2.4% Clove, G = 3.2% Clove extract treated, H = 1.6% ginger + Clove extract treated, I = 2.4% ginger + Clove extract treated, J = 3.2% ginger + Clove extract treated.

Table 3: Distribution of Responses on HEDONIC SCALE for various treatments of fermented *Prosopis africana* seeds on the 6th day of storage

Option	Scale	A	B	C	D	E	F	G	H	I	J
Like extremely	9	0	0	0	0	0	0	0	0	0	0
Like very much	8	0	0	1	1	0	1	3	4	4	5
Like moderately	7	0	3	2	3	5	4	3	5	4	5
Like slightly	6	0	5	6	5	4	5	4	1	2	0
Neither like nor dislike	5	0	0	0	1	1	0	0	0	0	0
Dislike slightly	4	1	1	1	0	0	0	0	0	0	0
Dislike moderately	3	1	1	0	0	0	0	0	0	0	0
Dislike very much	2	6	0	0	0	0	0	0	0	0	0
Dislike extremely	1	2	0	0	0	0	0	0	0	0	0
Mean ± Standard error		2.1± 0.28	5.8± 0.42	6.2 ± 0.33	6.4 ± 0.27	6.4 ±0.22	6.6 ± 0.22	6.9 ± 0.28	7.3 ± 0.22	7.2 ± 0.25	7.1 ± 0.38
Total responses		10	10	10	10	10	10	10	10	10	10
% Dislike		100	20	10	0	0	0	0	0	0	0
Comments		Objectional odour						Good aroma and taste			
Number of days taken before spoilage		4	6	7	8	10	11	11	11	>12days	

Key: A = Control, B = 1.6% ginger extract treated, C = 2.4% ginger extract treated, D = 3.2% ginger extract treated, E = 1.6% Clove extract treated, F = 2.4% Clove, G = 3.2% Clove extract treated, H = 1.6% ginger + Clove extract treated, I = 2.4% ginger + Clove extract treated, J = 3.2% ginger + Clove extract treated.

Table 4.: Distribution of Responses on HEDONIC SCALE for various treatments of fermented *Prosopis africana* seeds on the 9th day of storage

Option	Scale	A	B	C	D	E	F	G	H	I	J
Like extremely	9	0	0	0	0	0	0	0	0	0	0
Like very much	8	0	0	0	1	0	0	0	0	1	2
Like moderately	7	0	3	2	3	4	7	7	8	7	8
Like slightly	6	0	0	2	1	6	3	3	2	2	0
Neither like nor dislike	5	0	0	0	0	0	0	0	0	0	0
Dislike slightly	4	0	0	3	2	0	0	0	0	0	0
Dislike moderately	3	0	7	3	3	0	0	0	0	0	0
Dislike very much	2	4	0	0	0	0	0	0	0	0	0
Dislike extremely	1	6	0	0	0	0	0	0	0	0	0
Mean ± Standard error		1.4 ± 0.17	4.2 ± 0.61	4.7 ± 0.52	5.2 ± 0.63	6.4 ± 0.17	6.7 ± 0.15	6.7 ± 0.15	6.8 ± 0.13	6.9 ± 0.18	6.5 ± 0.62
Total responses		10	10	10	10	10	10	10	10	10	10
% Dislike		100	70	60	50	0	0	0	0	0	0
Comments		Objectional odour							acceptable due to good taste		
Number of days taken before spoilage		4	6	7	8	10	11	11	11	>12days	

Key: A = Control, B = 1.6% ginger extract treated, C = 2.4% ginger extract treated, D = 3.2% ginger extract treated, E = 1.6% Clove extract treated, F = 2.4% Clove, G = 3.2% Clove extract treated, H = 1.6% ginger + Clove extract treated, I = 2.4% ginger + Clove extract treated, J = 3.2% ginger + Clove extract treated.

Table 5: Distribution of Responses on HEDONIC SCALE for various treatments of fermented *Prosopis africana* seeds on the 12th day of storage

Option	Scale	A	B	C	D	E	F	G	H	I	J
Like extremely	9	0	0	0	0	0	0	0	0	0	0
Like very much	8	0	0	0	0	0	0	0	1	1	5
Like moderately	7	0	0	1	2	1	3	3	4	6	2
Like slightly	6	0	2	5	3	4	3	5	4	1	2
Neither like nor dislike	5	0	0	0	2	3	2	1	0	2	1
Dislike slightly	4	0	4	2	2	1	2	1	1	0	0
Dislike moderately	3	0	4	2	1	0	0	0	0	0	0
Dislike very much	2	2	0	0	0	1	0	0	0	0	0
Dislike extremely	1	8	0	0	0	0	0	0	0	0	0
Mean ± Standard error		1.2 ± 0.13	4.0 ± 0.37	5.1 ± 0.46	5.3 ± 0.42	5.2 ± 0.44	6.1 ± 0.38	6.0 ± 0.30	6.4 ± 0.34	6.6 ± 0.31	7.1 ± 0.35
Total responses		10	10	10	10	10	10	10	10	10	10
% Dislike		100	80	40	30	20	20	10	10	0	0
Comments		Objectional odour					Unacceptable due to offensive odour				
Number of days taken before spoilage		4	6	7	8	10	11	11	11	>12days	

Key: A = Control, B = 1.6% ginger extract treated, C = 2.4% ginger extract treated, D = 3.2% ginger extract treated, E = 1.6% Clove extract treated, F = 2.4% Clove, G = 3.2% Clove extract treated, H = 1.6% ginger + Clove extract treated, I = 2.4% ginger + Clove extract treated, J = 3.2% ginger + Clove extract treated.

Table 6: Means of different Responses on HEDONIC SCALE for various treatments of fermented *Prosopis africana* seeds from 0-12th days of storage

	Time of Storage				
Treatments	0 day	3days	6days	9days	12days
A	7.7^{a}±0.26	7.5^{a} ±0.17	2.1^{a} ±0.28	1.4^{a} ±0.17	2.1^{a}±0.13
B	8.3^{b} ±0.15	8.1^{b} ±0.18	5.8^{b} ±0.42	4.2^{b} ±0.61	4.0^{b} ±0.37
C	8.7^{c} ±0.15	8.3^{c} ±0.22	6.2^{c} ±0.33	4.7^{c} ±0.52	5.1±0.46
D	8.5^{c} ±0.17	8.2^{c} ±0.17	6.4^{c} ±0.27	5.2^{d} ±0.63	5.3^{d} ±0.42
E	8.6^{d} ±0.17	8.3^{c} ±0.26	6.4^{c} ±0.22	6.4^{e} ±0.17	5.2^{d} ±0.44
F	8.6^{d} ±0.17	8.0^{d} ±0.30	6.6^{c} ±0.22	6.7^{f} ±0.15	6.1^{e} ±0.38
G	8.7^{d} ±0.15	8.2^{d} ±0.20	6.9^{d} ±0.28	6.7^{f} ±0.15	6.0^{e} ±0.30
H	9.0^{e} ±0.00	8.7^{e} ±0.15	7.3^{e} ±0.22	6.8^{f} ±0.13	6.4^{f} ±0.34
I	9.0^{e} ±0.00	9.0^{f} ±0.18	7.2^{e} ±0.25	6.9^{f} ±0.18	6.6^{f} ±0.31
J	9.0^{e} ±0.00	9.0^{f} ±0.00	7.1^{e} ±0.38	6.5^{g} ±0.62	7.1^{g} ±0.35
P-value	**0.01**	**0.01**	**0.00**	**0.02**	**0.01**

p≤ 0.05 Values are means ±SE of three replicate. Means in the same column with the different superscript are statistically significant.

Key: A = Control, B = 1.6% ginger extract treated, C = 2.4% ginger extract treated, D = 3.2% ginger extract treated, E = 1.6% Clove extract treated, F = 2.4% Clove, G = 3.2% Clove extract treated, H = 1.6% ginger + Clove extract treated, I = 2.4% ginger + Clove extract treated, J = 3.2% ginger + Clove extract treated.

DISCUSSION

The rise in pH during fermentation may be due to the high proteinase activity of the microorganisms involved (Balogun, 2012), which ultimately resulted in the liberation of ammonia. The pH of *Okpehe* being slightly alkaline agrees with earlier reports of Oguntoyinbo.(6-8), where they recorded a slightly alkaline pH in fermented food condiments from vegetable proteins. The increase in pH is generally due to the production of ammonia, which is characterized by the pungent smell of fermented condiments. Balogun (2012) also agreed with this analysis in their research on the fermentation of *Prosopis* using different densities (pH rose from 6.43 - 8.41).

Temperature increased from (35.36-45.54)^{0}C in all the treatments, the rise in temperature is an indication that the fermentation process was accompany with the release of heat due to the metabolic activities of the microorganisms involved. Ibrahim *et al.* (2013) did a similar report which reported that the increase in temperature during the fermentation might be due to the growth and development of microorganisms liberating heat in the process.(9) Balogun (2012) also agreed with this analysis in their research on the fermentation of *Prosopis* using different bacteria concentration (Temperature increase from 24^{o}C to 30^{o}C).

On the sensory evaluation of the samples, the samples were liked by most of the judges probably because they looked fresh; this is because the texture of foods is mostly determined by the moisture and fat contents and the types and amounts of structural carbohydrates and proteins that were present in foods.(4,11)

On the average Samples I and J (100%), G and H (90%), E and F (80%), D (70%) and C (60%) were rated highest by the panelists in terms of colour probably because it looked fresh,while samples B were rated (20%) and sample A were least rated (0%) on the twelve days of preservation, this observation may be due to the fact that, combination of the spices drastically reduce the water activity of *Prosopis africana*

condiment and thus discouraged microbial growth. This observation was consistent with the findings of Balogun.(4)

CONCLUSION

The production of Okpehe from Prosopis africana seeds using spontaneous fermentation method was achieved. The parameters checked at intervals during the fermentation showed an average pH and temperature of 7 and 37°C respectively at 72hrs of fermentation and on sensory evaluation, all the Yajin Okpehe formulations were highly acceptable with the most acceptable to the taste panelist being Okpehe sample treated with combination of clove and ginger.

ACKNOWLEDGMENT

The researcher would like to express gratitude to all parties involved in this research, including the student respondents residing in the dormitories of the esteemed Santa Elisabeth College of Health Sciences Medan, as well as the team's lecturers and students who collaborated in conducting the research.

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