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Effect of Smoke Drying Techniques on the Proximate and Mineral Composition of *Macrobrachium vollenhovenii* (African River Prawn)

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***Abstract*—**This study was carried out to evaluate the nutritional composition of the African River Prawn (*Macrobrachium vollenhovenii*) in relation to Chokor (traditional) and Altona (improved traditional) drying techniques used in the preservation and processing of prawns by carrying out proximate composition analysis. The value obtained for the proximate analysis of Chokor and Altona smoke dried prawns were; Moisture (14.90% and 15.15%), Dry matter (85.10% and 84.85%), Protein (55.80% and 58.87%), Crude fat (1.95% and 1.98%), Crude fibre (21.40% and 13.11%), Carbohydrate (0.54% and 0.54%) and Ash (19.76% and 15.86%) respectively. The proximate mineral composition of Chokor and Altona smoke dried prawns were; Calcium (5.66% and 4.20%) and Phosphorus (9. 22% and 6.34%) respectively. Result shows there was no loss of nutritional value with respect to Chokor and Altona drying techniques used in the processing of prawns.

***Keywords*—**Altona, Chokor, *Macrobrachium vollenhovenii*, Proximate composition, Smoke drying.

I. Introduction

SHELL fish comprise crustaceans and molluscs and include various families, orders, generas and species of aquatic animals and a few land representatives. Crustaceans form a greater proportion of shell fish and include prawns, shrimps, crayfish and lobster [1]. Freshwater prawns of the genus *Macrobrachium* belongs to the family *Palaemonidae*, infra order *Caridea* and the order *Decapoda*. "Decapods" as they are collectively called, comprise of crustaceans having bodies divided into twenty segments with each carrying a pair of appendage and a characteristic five pairs of walking and swimming legs. They inhabit fresh and brackish (estuarine) water environments of the tropical world thus depicting their cosmopolitan nature.

In Nigeria, prawn production lies mainly in the hands of artisanal fishermen and women using artisanal fishing gears like basket and traps for marketable prawns. They are then transported and concentrated in open and organised markets where they are sold fresh, frozen, and dried (through sun drying and smoke drying) [2]. Preservation and processing are means of prolonging the shelf-life of fish products in acceptable quality through changes in texture, taste and appearance without adversely affecting the chemical nature of the product. Preservation methods apply the principle of temperature reduction by the use of ice-freezing, ice-blasting and/or chilling. It can be inferred that preservation itself does not help in the prevention but reduces spoilage to a large extent [3]. Processing methods apply the principle of temperature elevation and these include drying either through solar energy (sun drying), smoking, freeze-drying, canning, salting and boiling.

The objective of processing is to render the causes of spoilage inert, stop bacteria action and prevent contamination by insect. Processing methods aim at obtaining a more stable product even after off season [4], [5]. Clucas [4] defined drying as the removal of water from fish, shell fish and fish products, and this essentially is done by evaporation through natural resources such as the sun and wind, prolonged smoking or by electricity using electric ovens. Bostock et al. [2] reported that fish dry slowly if the weather is wet and humid; as the air is already saturated with water and little evaporation can take place from the fish surface and as such the lower the relative humidity, the faster the rate of drying. Also, increased air speed result in faster drying rate. Drying of shell fish (crustaceans) takes lesser period of time when compared to that of fin fish due to its small surface area to volume ratio [6].

Generally, crustacean (prawn) flesh is rich in lipids, protein, and free amino acids with a high a tendency to perish very quickly. Thus in order to ensure that products reach the consumer in good condition, attention to quality control and careful handling is essential right through all stages of harvesting, processing and marketing [1]. The handling, processing and distribution of fish, fishery products and indeed prawns should be carried out in a manner which will maintain the nutritional value, quality and safety of the products, reduce wastage and minimize negative impacts on the environment [7]. Hence, this study was carried out to evaluate the potential nutritional content of prawns in relation to Chokor and Altona smoke drying techniques used in processing of prawns.

II. Material and Methods

A. Collection of Samples

Macrobarchium vollenhovenii samples were obtained at

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Iguoriakhi terminus of Ovia River in Ovia South-West L.G.A of Edo State, Nigeria.

B. Sample Preparation

Eighty samples of fresh water prawns (*M. vollenhovenii*) were used for the study (Fig. 1). The prawns were divided into two halves; One-half was set for drying using the Chokor smoking kiln (Fig. 2) and the other for the Altona smoking kiln (Fig. 3). Prior to the use after procurement, the specimens were kept refrigerated after transportation from the capture site to prevent deterioration and spoilage before processing. The frozen *M. vollenhovenii* samples were removed from the freezer and allowed to thaw in a bowl at room temperature of 29°C for 30 minutes, weighed in batches and air dried before being transferred to the different drying facilities provided; Chokor smoking kiln and Altona smoking kiln. The prawns were smoke dried for about 3 hours.

Fig. 1 Fresh *M. vollenhovenii* samples

Fig. 2 Chokor Smoking Kiln

Fig. 3 Altona Smoking Kiln

C. Extraction Procedure

The extraction procedure and methods of analysis were that of the Association of Official Analytical Chemist (AOAC) [8]. These were mainly spectrophotometer, gravimetric and titrimetric methods.

D. Statistical Analysis

All quantitative data were expressed as the mean ± standard error of mean (SEM). Statistical analysis was carried out using student t-test and significant difference between means, were assessed at 95% level of significance using Primer (v.3.01).

III. Results

TABLE I
RESULT OF PROXIMATE ANALYSIS FOR CHOKOR AND ALTONA SMOKE DRIED *M. VOLLENHOVENII*

Parameter %	Chokor Smoke Dried	Altona Smoke Dried
Moisture	14.90 ± 0.60	15.15 ± 0.26
Dry matter	85.10 ± 0.60	84.85 ± 0.26
Protein	55.88 ± 2.04	58.87 ± 1.28
Crude fat	1.95 ± 0.27	1.98 ± 0.50
Crude fibre	21.12 ± 5.08	13.11 ± 1.62
Carbohydrate	0.54 ± 0.00	0.54 ± 0.00
Ash	19.76 ± 1.14	15.88 ± 0.82

Mean ± SEM, n=2

TABLE II
RESULT OF PROXIMATE MINERAL COMPOSITION FOR CHOKOR AND ALTONA SMOKE DRIED *M. VOLLENHOVENII*

Mineral Composition %	Chokor Smoked Dried	Altona Smoke Dried
Calcium	5.66 ± 0.51	4.20 ± 0.34
Phosphorus	9.22 ± 0.60	6.34 ± 0.67

Mean ± SEM, n=2

IV. Discussion

The proximate analysis of smoke dried *M. vollenhovenii* indicates that the moisture content of the Chokor smoked prawns (14.90%) was lower than that of the Altona smoked prawns (15.15%). This is attributed to the fact that the heat generated by the Altona smoking kiln was more controlled

than the Chokor smoking kiln. The values were in line with work by [9] which gave a range of 10-15% moisture content for smoke dried fish products.

The protein content of *M. vollenhovenii* is generally high and forms the bulk of dry matter as shown in Table I. This result agreed with other studies which stated that protein is the most prominent biochemical component of crustaceans [10]-[14]. The protein content of *M. vollenhovnii* (55.88-58.87%) agreed with that recorded by [12] for M. idea (57.32-61.44%) and [11] (53.38%) for whole *M. vollenhovenii* prawn.

The values were higher than smoke dried *Penaeus notialis* recorded by [10] (15.64%) but lower than the value for the whole prawn by [13] (69.71%) for whole *M.vollenhovenii.*

The crude fat content of Chokor and Altona smoke dried *M. vollenhovenii* were 1.95% and 1.98% respectively as shown in Table I. The values were quite low compared with findings of other research works carried out on prawns and shrimps [11]-[15]. However, [10] reported a crude fat value of 4.67% for smoke dried prawns representing the lowest value for fresh and other processed samples of *P. notialis*.

The low value of crude fat in both the Chokor and Altona smoked prawns can therefore be linked to the heat applied during the smoke drying process through burning out of the fat as a means of reducing rancidity and hence extending the shelf-life of the processed prawns.

The crude fibre as reported in Table I was 21.12% and 13.11% for Chokor and Altona smoke dried prawns, respectively. The values were higher than those reported by [10] for *P. notialis*, [13] for *M. vollenhovenii*, [16] for *Penaeus notabilis*, and [11] for *M. vollenhovenii* and M*acrobrachium macrobrachion* and [15] for *M. macrobrachion.* However, the crude fibre value reported for the Chokor smoke dried prawns far exceeded that of the Altona smoke dried prawns. This may be linked to the uncontrolled nature of the heat generated from the Chokor smoking kiln as compared to closed chamber Altona kiln.

The carbohydrate content reported for the two smoke dried samples were generally low (0.54%). This is in contrast with values reported by [10] for smoke dried *P. notialis* (44.56%), [11] (9.29%) for the whole prawn of *M. vollenhovenii*, [15] for *M. macrobrachion* and relatively lower than that reported by [13] (1.70%) for whole prawn of *M. vollenhovenii*, [16] (1.6%) and (2.6%) for shell and flesh of *P. notabilis* respectively and [14] (1.89%) and (1.91%) for edible muscles male and female *Penaeus indicus* respectively. The Ash content gave a value of (19.76%) and (15.88%) for Chokor and Altona smoke dried prawns respectively as shown in Table I. This is comparable but lower than research findings by [11] 25.33% for whole prawn and 20% for edible portion, [16] 28.5% and 19.9% for the shell and flesh of *P. notabilis* respectively and higher than value recorded by [10] for smoke dried *P. notialis* (17.76%), [13] for whole prawn (10.28%), edible portion (10.31%) and exoskeleton and appendages (10.55%) of *M. vollenhovenii* and [15] for flesh (4.30%), appendages (7.01%) and exoskeleton (7.14%) respectively.

The composition of the two most important minerals component in crustaceans as shown in Table II is given as Calcium (5.66% and 4.20%) and Phosphorus (9.22% and 6.34%) for Chokor and Altona smoke dried prawns respectively. The results were observed to be higher compared to work by [17] with reported values of (1.05%) and (1.05%) of calcium and phosphorus respectively for semi-dried *Penaeus monodon* Prawns. Other findings on similar conducted research include varying report by [14] with calcium values of (45.09 mg/100g) and (39.96 mg/100g), potassium values (74.32 mg/100g) and (75.45 mg/100g) for edible muscles of male and female *P. indicus* respectively. Ehigiator and Oterai [13] recorded calcium value of (51.21mg/100g) and phosphorus value of (102.67 mg/100g) for whole prawn of *M.vollenhovenii* and [16] reported calcium value of (57.90 mg/100g and 46.90 mg/100g) and phosphorus value of (95.70 mg/100g and 86.70 mg/100g) for shell and flesh of *P. notabilis* respectively.

V. Conclusion

The results of this study have shown varying values of essential nutrients in the two drying methods employed. The research also shows that there is no significant difference in the nutritional value of the two smoke drying techniques employed. However, the Altona smoke dried prawns indicated a slightly higher crude protein value which is the most important nutritional component of prawns. Crude fat content was relatively close for both the Chokor smoke dried and the Altona smoke dried prawns. Carbohydrate content was observed to be equal for both smoking kilns. The crude fibre content of the Chokor smoked dried was observed to exceed that of the Altona smoke dried. This fact is attributed to the somehow uncontrollable heat generated by the Chokor smoking kiln and hence the tendency for the smoke-dried products to be “charred”.

The afore-mentioned reason also account for the higher values observed for the total ash content as well as the two prominent mineral composition of crustaceans (Calcium and Phosporus) for the Chokor smoke dried prawns as against the Altona smoke dried prawns. The efficiency of the smoke drying facilities (kilns) employed should be geared towards improving the quality of the output. This will ensure optimization of the entire smoke drying process from capture / culture through the various inputs of production (materials and labour) to the finished products thus adding value to the marketability and profitability of prawns in general.

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