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Chemical and Sensory Characteristics of Gari as Affected by the Stage at which Crude Palm Oil was Added to Cassava

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Abstract: *The present study assessed the chemical and sensory characteristics of yellow gari as affected by the stage at which crude palm oil was added to cassava. Two yellow gari samples were studied: one from cassava mash in which palm oil was added prior to fermentation (POF), and the other from cassava in which palm oil was added at the garifying (roasting) stage (GPO). Both samples were subjected to evaluation of chemical and sensory characteristics. White gari from cassava with no added palm oil was also subjected to analyses, and served as the control. Findings from this work indicate that POF and GPO recorded higher values of protein (3.74 and 3.44% respectively) than the control (2.18%); higher values of fat (1.25 and 3.40% respectively vs. the 0.20% for the control); higher values of vitamin A (107.10 and 105.75mg/100g respectively vs. 47.95 mg/100g for the control); and lower values of hydrogen cyanide (2.20 and 4.95mg/kg respectively vs. 8.09mg/kg for the control). Comparing values of POF and POG, addition of palm oil prior to fermentation led to significant decrease in hydrogen cyanide while addition of palm oil at garifying stage led to significant increase in fat. In terms of acceptability of aroma, mouthfeel, taste and overall acceptability, yellow gari (POF and GPO) were generally preferred over white gari (WGA); however, in terms of the stage at which palm oil was added, POF was preferred by panellist in all the attributes evaluated, with the exception of colour which recorded acceptability score of 8.00 for GPO vs. 6.55 for POF.*

Keywords: *Cassava; Crude palm oil; Fermentation; Garifying; Gari*.

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I. Introduction

Cassava (*manihot esculenta crantz*) is a cheap source of carbohydrate in the diet of a good percentage of the population in Africa where it is largely cultivated. The tuber has a very short shelf life and must be processed into acceptable forms. It may be boiled and consumed with local sauces, sundried and ground into flour form for use in preparation of local diets or processed into tapioca. In most cases, cassava tuber is grated, fermented and roasted into gari – a lactic acid fermented product. The chemical composition of cassava has been studied extensively and literature report indicates that cassava tuber has an average composition of 60-65% moisture, 30-35% carbohydrate, 1-2% crude protein, 0.2-0.3% fat, a comparatively low content of vitamin C, and nutritionally significant amounts of thiamine, riboflavin and nicotinic acid[1].

Traditionally, gari is prepared from cassava roots by fermenting peeled and mashed cassava pulp in jute bags for a period of up to 3days. This is followed by light roasting in shallow metal vet placed in open fire after sieving to remove coarse particles. The resulting dry granular gari can be stored for periods[2]. Lately, the production of gari involves semi-mechanised and integrated accelerator methods, however, the traditional method has gained wide acceptance and is the most popular amongst households[3]. The major problem associated with the consumption of gari is the toxicity which may arise from poor processing of cassava, which is rich in cyanogenic glycosides. However, the traditional method of gari production which involves fermentation during which the cyanides are hydrolysed by linamarase to yield hydrocyania acid which has low boiling point and easily lost during garifying, renders the gari safe for consumption. Gari comes in two forms: cream-white or light-yellowish and yellow or deep yellow; and this colour difference depends on whether or not crude palm oil was added during the course of processing cassava mash into gari. Yellow gari is obtained either by mixing the mashed cassava pulp with crude palm oil (rich in carortenoid) prior to fermentation or by adding few drops of palm oil during the garifying (or roasting) stage. White gari is as a result of the absence of palm oil throughout the processing stages. The presence of absence of palm oil depends on the dietary habit of each community; likewise, the stage at which palm oil is added also varies from community to community. In some rural communities, palm oil is added to cassava mash prior to fermentation stage while in other, oil is added after fermentation, at the garifying stage. It is therefore important to understand the nutritional and sensorial implications of this variation in the use of palm oil. While there is plethora of information on the physicochemical properties of gari brought about by fermentation time[4,5,6], there is lack of information on the

changes occurring in the chemical and nutritional properties of gari as a result of the stage at which palm oil is added to cassava mash, hence, the objective of this work.

II. Materials And Methods

3.1 Source and Preparation of Raw Material

The cassava tubers used for this study were obtained from a local farm while crude palm oil was purchased from a local store in Abakaliki, Ebonyi State. Cassava was processed into gari following the procedure reported by James et al.[6], with modification. The tubers were peeled using stainless steel knife to expose the fleshy white part which was washed with clean water and further grated into a mash using local cassava grating machine. The mash was weighed and divided into 3 equal portions. The first portion was thoroughly mixed with crude palm oil, placed in a jute bag and dewatered by compression using hydraulic press; then allowed to ferment for 48 hours. The wet cake obtained was sieved into grits and garified (roasted) (with no further addition of palm oil) into yellow gari. This portion was coded POF.

The second portion was placed in a jute bag (no palm oil was added), dewatered and fermented for 48 hours after which it was sieved and garified with the addition of palm oil, into yellow gari. This portion was coded GPO. The third portion was placed in a jute bag (no palm oil was added), dewatered and allowed to ferment for 48 hours. The wet cake obtained was sieved into grits and garified (with no added palm oil) into white gari. This portion served as the control and was coded WGA. Both the samples (POF and GPO) and control (WGA) were subjected to chemical and sensory evaluation as follows:

3.2 Chemical properties

Chemical properties were evaluated according to AOAC official methods of analysis[7]. Crude protein content was determined using micro-Kjeldahl method, crude fat was determined by Soxhlet extraction method, ash by incinerating samples at 600 °C in a muffle furnace and moisture content in a convection oven; while carbohydrate was calculated by percentage difference. Vitamins A and hydrogen cyanide were determined spectrophotometrically[7].

3.3 Sensory Evaluation

Fifteen panelists were selected from students of the Department of Food Science and Technology, Ebonyi State University, Abakaliki. The panelists were screened using the triangle test[8] and selected based on their ability to consistently discriminate between white gari and yellow gari. Gari samples were evaluated by rating on a 9-point hedonic scale, where 1 = dislike extremely, 5 = neither like nor dislike, and 9 = like extremely, according to acceptability of colour, aroma, taste, mouthfeel and overall acceptability. Evaluation of sensory attributes of samples was carried out based on the recommendations described by Malcolmson[9].

3.4 Statistical Analysis

Analytical data were processed using SPSS 16.0 for windows (SPSS, Chicago, IL, USA) and are expressed as means of three replicates. One way ANOVA was used to test differences and significance was established at $P<0.05$.

III. Results And Discussion

Moisture content of samples as shown in table 1 ranged from 9.70-11.56% with yellow gari samples (POF and GPO) having lower moisture content than white gari (WGA) (control). These values are less than 7% stipulated by Nigerian Industrial Standard[10] as upper limit for gari but lower than 12% recommended by Codex Standard[11] as the maximum moisture content for shelf stable gari. Similar values as those in table 1 have been reported for gari[12,13] . There was no significant difference between the moisture content of POF and GPO. In terms of protein content, addition of palm oil led to increase in protein content and is in conformity with the findings of Abu et al.[14]. Yellow gari samples recorded significantly higher ($p<0.05$) values of protein that the control. This could be attributed to fermentation and particularly to the action of fermenting microorganism, as microbial fermentation can break down components of their substrates, releasing bound nutrients[4,5]. The ability of microorganisms to synthesize amino acids may be the reason for the protein increase observed in samples FPO and GPO. As expected, the addition of palm oil brought about an increase in fat content. Compared to the control (WGA), there was substantial increase in the fat contents of POF and GPO (table 1). On the other hand, GPO recorded significantly higher ($p<0.05$) fat content than POF which suggests that substantial amount of palm oil was lost during the process of dewatering by compression using hydraulic press (section 3.1). This is also an indication that more fat is incorporated into gari when oil is added at the garifying stage. The ash content of samples ranged from 1.50-2.25% with the yellow samples recording higher values than the control, indicating higher mineral content compared to the control. The ash contents shown in table 1 are within the NIS[10] limit of 1.5% stipulated for gari. There was no significant difference ($p>0.05$) between the ash contents of WGA, POF

and GPO. In contrast to ash, fibre contents of POF and GPO were less than that of WGA, suggesting that fibre decreased with the addition of palm oil. This is in contrast to the literature report[13] that increased fibre content was observed for yellow gari. However, there was no significant difference ($p>0.05$) between the fibre contents recorded for the samples studied. Carbohydrates ranged from 78.71-81.36% and were within the range expected for gari.

Table 1: Chemical properties of gari samples

Composition	WGA	POF	GPO
Proximate (%)			
Moisture	$11.56^{a} \pm 0.44$	$10.10^{b} \pm 0.30$	$9.70^{b} \pm 0.48$
Protein	$2.18^{a} \pm 0.2$	$3.74^{b} \pm 0.50$	$3.44^{b} \pm 0.45$
Fat	$0.20^{a} \pm 0.02$	$1.25^{b} \pm 0.13$	$3.40^{c} \pm 0.10$
Ash	$1.50^{a} \pm 0.08$	$1.71^{a} \pm 0.37$	$2.25^{a} \pm 0.20$
Fibre	$2.60^{a} \pm 0.13$	$2.20^{a} \pm 0.18$	$2.50^{a} \pm 0.21$
Carbohydrate	81.36	81.00	78.71
Vitamin A mg/100g)	$47.95^{a} \pm 1.55$	$107.10^{b} \pm 1.70$	$105.75^{b} \pm 1.65$
HCH (mg/kg)	$8.09^{a} \pm 1.20$	$2.20^{b} \pm 0.33$	$4.95^{c} \pm 0.75$

Values are mean ±SD (n=3); Means on the same row, with different superscripts are significantly different ($p< 0.05$). WGA = white gari (control); POF = yellow gari from cassava with added palm oil prior to fermentation stage; GPO = yellow gari from cassava with added palm oil at garifying stage.

The addition of palm oil appeared not to have noticeable impact on carbohydrate content. Vitamin A content increased significantly ($p<0.05$) with the addition of palm oil. This was expected as crude palm oil is a rich source of vitamin A. There was no significant difference ($p>0.05$) between the stages at with palm oil was added. On the other hand, values for hydrogen cyanide (HCN), the major toxic compound associated with gari, in all samples studied were below the 20mg/kg limit established by the Nigerian Industrial Standard for gari[10]. Compared to WGA, POF and GPO recorded significantly lower ($p<0.05$) HCN content indicating that the addition of palm oil resulted in reduction of HCN and stressing that palm oil can contribute in detoxifying cassava. Reduction in HCN of gari due to addition of palm oil has been reported by many authors[14,15]. POF recorded significantly lower ($p>0.05$) HCN values than WGA and GPO, suggesting that there was more reduction in HCN when palm oil was added to cassava before fermentation as opposed to when it was added during garifying. Like palm oil, fermentation has also been identified to be effective in detoxifying cassava[15] so the relatively great decrease observe in POF (table 1) may be attributed to a combined effect of fermentation and palm oil (since palm oil was added prior to fermentation (section 3.1)).

Sensory evaluation results are shown in table 2. Gari from cassava with palm oil added at the garifying stage (GPO) recorded higher ($p<0.05$) colour acceptability score than the control (WGA) and the gari from cassava with oil added before fermentation. POF was the least preferred sample in terms of colour, indicating that the addition of palm oil prior to fermentation did not improve the characteristic light-yellowish colour of gari. Mean scores for acceptability of aroma, mouthfeel and taste were significantly higher ($p<0.05$) for POF than for WGA (control) and GPO. No significant difference ($p>0.05$) was observed between GPO and WGA for the above attributes. The rating for overall acceptability (table 2) indicates that the panellists generally preferred yellow gari from cassava in which palm oil was added prior to fermentation, to yellow gari from cassava in which palm oil was added at the garifying stage. In addition, the panellists generally showed the same degree of preference ($p>0.05$) for white gari (the control) and yellow gari from cassava with oil added during garifying (GPO).

Table 2: Sensory evaluation of gari samples

Attribute	WGA	POF	GPO
Colour	7.45 ± 1.54^{a}	6.55 ± 1.60^{a}	8.00 ± 0.90^{b}
Aroma	6.00 ± 1.58^{a}	8.00 ± 0.82^{b}	6.50 ± 2.09^{a}
Mouthfeel	5.65 ± 2.40^{a}	7.65 ± 1.50^{b}	6.60 ± 2.11^{c}
Taste	5.90 ± 2.31^{a}	7.75 ± 1.27^{b}	5.5 ± 02.66^{a}
Overall Acceptability	6.55 ± 1.47^{a}	7.70 ± 1.13^{b}	6.80 ± 1.60^{a}

Values are means ± SD (n=3); Means with different superscript on the same row are significantly different ($p<0.05$). WGA = white gari (control); POF = yellow gari from cassava with added palm oil prior to fermentation stage; GPO = yellow gari from cassava with added palm oil at garifying stage.

IV. Conclusion

Finding from the present work indicate that the addition of palm oil to cassava, has significant impact on the chemical and sensorial characteristics of gari obtained. However, in terms of the stage at which palm oil was added, there was no significant impact on the chemical characteristic with the exception of fat content which showed the highest increase when oil was added at the garifying stage; and hydrogen cyanide which

recorded the least value when oil was added to cassava prior to fermentation. Highest colour acceptability rating was observed for sample from cassava in which palm oil was added at the garifying stage (GPO) while highest acceptability for aroma, mouthfeel and taste was observed for the gari from cassava in which palm oil was added prior to fermentation (POF). The panellists neither liked nor disliked the taste of GPO. The addition of palm oil at garifing stage increased the fat content of gari; while the addition of oil prior to fermentation lowered HCN content and generally improved the organoleptic characteristics of the gari.

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