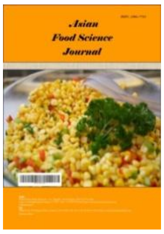

Asian Food Science Journal

21(4): 34-42, 2022; Article no.AFSJ.81651
ISSN: 2581-7752

Effect of Blanching on the Physicochemical Characteristics, Nutrient Composition and Sensory Properties of 'Banga' Sauce Produced from Fresh Oil Palm Fruits

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AFSJ/2022/v21i430423

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/81651

Original Research Article

Received 08 December 2021
Accepted 11 February 2022
Published 13 April 2022

ABSTRACT

Banga sauce is the concentrated mesocarp juice of oil palm fruits. This work is aimed at evaluating the effect of blanching on the physicochemical characteristics, nutrient composition and sensory properties of 'Banga' sauce. Ripe and fresh fruits of the oil palm (*Elaeis guineensis*) were blanched in batches at 100^{0}C for 0 to 25 min, extracted and concentrated as banga sauce. Samples were labeled A, B, C, D and E, for 0, 10, 15, 20 and 25 min blanching time, respectively. Moisture content was significantly ($p<0.05$) high (76.37 – 80.66%) and decrease significantly ($p<0.05$) with increase in blanching time. Percentage fat content of sample A was low (1.62%). Differences in protein content were not statistically significant. Carbohydrate content of sample E was 17.38%. Differences in peroxide value, iodine value and saponification value of the sauce were not statistically significant. Melting point, viscosity and density were respectively 36.44°C, 35.00 cSt and 0.9968, these values decrease significantly with increased blanching time. Solid fat content of unblanched banga sauce was significantly high (75%) at refrigeration temperature (5°C), with significantly lower value of 55% seen in sample E. Taste scores for samples B and C were significantly higher followed by sample E. Overall acceptability scores ranged from 7.49 – 7.81, with sample C given higher value, though not statistically difference.

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Keywords: Banga sauce; blanching; palm fruits; physicochemical; sensory.

1. INTRODUCTION

Oil palm (*Elaeis guineensis*) is the highest yielding edible oil crop in the world, and is cultivated in forty-two countries on eleven million hectares worldwide [1]. The oil palm fruit, a drupe, varies between 20 and 50 mm in length and could be as large as 25 mm in diameter is found in bunches that are attached to the crown of the tree through a stalk [2,3]. The pericarp comprises three layers, namely the exocarp (the skin), mesocarp (the outer pulp containing palm oil) and endocarp (a hard shell enclosing the kernel (the endosperm) which contains oil and carbohydrate reserves for the embryo. Fruit development starts at about two weeks after anthesis. Oil deposition in the endosperm starts at about 12 weeks after anthesis and is almost completed by 16 weeks after anthesis [4]. Oil palm and its fractions are used in the manufacturing of cooking oil, margarines, spreads, ice creams and dairy products [5]. Concentrated oil palm fruit mesocarp juice (Banga sauce) is consumed by Africans especially those from Nigeria, Ghana, Ivory Coast and Sierra Leone.

Triacylglycerols are the main ingredients of palm oil, as they are in other oils. More than 95 percent of palm oil is made up of triglyceride combinations, each of which is esterified with three fatty acids. The hydrophobic triglycerides attract other fat- or oil-soluble cellular components that make up the minor components of palm oil, such as phosphatides, sterols, pigments, tocopherols, tocotrienols, and trace metals, during oil extraction from the mesocarp. Monoacylglycerols, diacylglycerols, and free fatty acids are also found in palm oil. Fatty acids are aliphatic acids found in animal and vegetable fats and oils, such as palmitic, stearic, and oleic. The major fatty acids in palm oil are myristic, palmitic, stearic, oleic and linoleic and most of the fatty acids are present as triglycerides. Palm oil is said to have almost equal levels of saturated and unsaturated fatty acids [6,7]. The minor elements are divided into two categories. The first category includes fatty acid derivatives such as monoacylglycerols, phosphatides, esters, and sterols, whereas the second group includes hydrocarbons, aliphatic alcohols, free sterols, tocopherols, pigments, and trace metals, which are not chemically connected to fatty acids. Sterols, higher aliphatic alcohols, pigments, and hydrocarbons make up the majority of the minor components discovered in the unsaponifiable portion of palm oil. Alkaline hydroxide, on the other hand, saponifies small components like partial glycerides and phosphatides [8,9]. The partial glycerides do not occur naturally in significant amounts except in palm oil from damaged fruits and such oils would have undergone partial hydrolysis resulting in the production of free fatty acids, water and partial glycerides [10,11].

Carotenoids are tetraterpenes that are extremely unsaturated and biosynthesized from eight isoprene units. Carotenoids are vitamin A precursors, with carotene having the most provitamin A activity. Palm oil has fifteen times the amount of retinol equivalents as carrot and three hundred times the amount of retinol equivalents as tomato. Carotenes are sensitive to oxygen and light, and hydroperoxides produced during lipid oxidation speed up the oxidation of carotenes, resulting in discolouration and bleaching [12].

Over 90% of the world oil production is used as food. This has necessitated that the nutritional, physico-chemical properties and its fractions be adequately demonstrated. Also, since palm oil and palm juice products have desirable physical and chemical characteristics for many food applications, it is therefore important to examine the physico-chemical properties of oil palm banga sauce processed at different blanching time. This work is aimed at evaluating the effect of blanching on the physicochemical characteristics, nutrient composition and sensory properties of 'Banga' sauce.

2. MATERIALS AND METHODS

2.1 Collection of Raw Materials

Mature and good quality oil palm fruits were purchased from the fruit market in Port Harcourt, Nigeria.

2.2 Preparation of Banga Sauce

Palm fruit juice for banga sauce was extracted using the method of Uroko [13], with slight modification, as shown in Fig. 1. The oil palm fruits were sorted, cleaned and washed. The washed fruits were placed in stainless steel pot and blanched in water at 100°C for 10 to 25min. While they were still hot, the palm fruits were pounded in a mortar with a pestle till all the flesh was separated from the nuts, forming a smooth pulp. The nuts were sorted from the pulp and washed in a small amount of warm water, while the pulp was wringed and set aside. Washing the pulp continued until the water becomes concentrated. The extracted palm fruit concentrate was left to stand for some time, and then slowly decanted to achieve the banga sauce.

2.3 Proximate Analysis

The moisture, crude protein (N x 6.25), crude fibre, crude fat and total ash contents of samples were analyzed using the method described by Association of Official Analytical Chemists' [14]. Total carbohydrate content of the samples was calculated by difference (subtracting the sum of percent moisture, crude protein, crude fibre, crude fat, and ash from 100%).

2.4 Physicochemical Analysis

Physicochemical properties including; iodine value, free fatty acids, peroxide value, saponification value, melting point and density were determined by the method of AOAC [14]. Kinematic viscosity was measured using the established procedure of the ASTM D 445 [15]. It was determined with a calibrated Cannon-Ubbelohde Viscometer: No 2 A149 (Cannon Instrument Co. PA, USA). The viscometer was charged with the oil sample and suspended vertically in a constant temperature bath. The temperature of the system was maintained at 40°C.

The efflux time of the oil through the capillary bulb was measured and recorded in seconds.

The Kinematic viscosity was calculated using the following formula:

$V = Kc \times t_f$
V = kinematic viscosity (mm^2/s)
Kc = Capillary factor/ Viscometer constant (mm^2/s^2)
t_f = Sample efflux time (s)
note: mm^2/s = cSt (centistokes)

2.5 Solid Fat Content (SFC)

The solid fat content-temperature profile was determined using the density method [16]. Density of solid fat is higher than the density of liquid oil, so density increases when fat crystalizes and decreases when it melts.

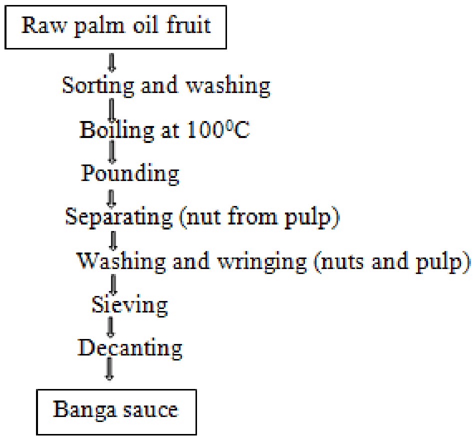

Fig. 1. Flow chart for the production of Banga Sauce [13]

The glass pycnometer was used to measure density at the following temperature: 5°C, 10°C, 15°C, 20°C, 25°C, 30°C, 35°C, 40°C, 45°C and 50°C. The percentage SFC was calculated using the following equation:

$$SFC\ (\%) = \frac{\rho - \rho l}{\rho s - \rho l} \times \frac{100}{1}$$

ρ = density of fat at the desired temperature
ρl =density of fat when completely liquid.
ρs =density of fat when completely solid.

2.6 Sensory Evaluation of Banga

Samples of banga sauce produced were subjected to sensory analysis on a nine-point Hedonic scale (1 and 9 representing extremely dislike and extremely like respectively), using the method of Iwe [17]. Twenty-five semi-trained panelists (students and staff of the Department of Food Science and Technology, Rivers State University, Port Harcourt, Nigeria) were used. The following quality attributes were assessed; appearance, colour, aroma, taste, texture, mouth feel and overall acceptability.

2.7 Statistical Analysis

All the analyses were carried out in triplicate. Data obtained were subjected to Analysis of Variance (ANOVA); differences between means were evaluated using Turkey's multiple comparison tests with 95% confidence level. The statistical package in Minitab software version 16 was used.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Blanched and Unblanched Banga Sauce

The result for proximate composition of banga sauce is shown in Table 1. Moisture, ash, fat, protein and carbohydrate content ranged from 71.79 – 80.66, 0.10 – 0.17, 1.62 – 5.73, 5.36 – 5.46 and 12.25 – 17.38 %, respectively. Moisture content of the sauce was significantly high. The higher the moisture contents of food the lower the shelf life stability [18]. High moisture content favours the development of contaminating microorganisms, whose growth and activities caused spoilage in food products. Ash content is a measure of mineral content of food [19,20]. The moisture contents were also shown to decrease significantly (p<0.05) with increase in blanching time. Significant difference in the ash content of the samples is probably due to leaching at different blanching time. Fat content of the unblanched banga sauce was significantly low (1.62%). There was however no significant difference in the protein content of the sauce samples. Carbohydrate content decreased with increased blanching time; this was probably due to decreased moisture content.

3.2 Physicochemical Properties

From the result in Table 2, peroxide value, iodine value, saponification value and free fatty acid content of the processed banga sauce ranged from 2.00 – 2.11 mEq/kg, 23.39 – 23.57 g/100 g, 81.56 – 81.63 mgKOH and 0.34 – 0.40%, respectively. There was no significant difference (p>0.05) in the peroxide value (PV) of the sauce samples. PV of the samples was much lower than 10mEq/kg, which is the maximum allowable standard of PV for edible oil [21]. This value was higher than 1.53 mEq/kg reported earlier by Chibor et al. [22]; this was probably due to varietal difference and processing method. Peroxide value (PV) is the milliequivalent (mEq) of oxygen per 100g of fat; it is used to indicate the degree to which a fat has been oxidized [23]. Oxidation of unsaturated oil takes place via the formation of hydroperoxides. The hydroperoxides been the primary products of oxidation however, do not have any off-flavour [23]. There was no significant difference (p>0.05) in the iodine value (IV) of banga sauce. IV of 33.24, 47.88 and 57.33 g/100g had earlier been reported for crude palm oil [23,24]. Iodine value is a simple chemical constant used to measure unsaturation or the average number of double bonds in an oil sample. It is defined as the number of grams of iodine that could be added to 100 g of oil [25].

There was no significant difference in the saponification value (SV) of the sauce samples; these values were however lower than 200.47 to 222.90 mgKOH/g SV for crude palm oil [23]. Saponification value is the amount of alkali necessary to saponify a definite quantity of the sample (oil). It is expressed as the number of milligrams of potassium hydroxide (KOH) required to saponify 1 g of the sample. The smaller the saponification number, the larger the average molecular weight of the triacylglycerol present in the oil [26]. Percentage free fatty acid (FFA) of the banga sauce showed significant difference (p<0.05); these values were also lower than 2.5% CODEX standard for vegetable oil [21]. Low FFA content of the oil shows that the oil has low susceptibility to enzymatic hydrolysis [27].

Table 1. Proximate composition (%) of banga sauce produced from fresh oil palm fruits

Sample	Moisture	Ash	Fat	Protein	Carbohydrate
A	80.66^{a}±0.431	0.10^{d}±0.000	1.62^{c}±0.134	5.37^{a}±0.012	12.26^{d}±0.097
B	76.37^{b}±0.163	0.14^{b}±0.000	5.64^{ab}±0.099	5.36^{a}±0.008	12.50^{d}±0.064
C	74.56^{bc}±0.000	0.17^{a}±0.005	5.73^{a}±0.134	5.46^{a}±0.000	14.09^{c}±0.070
D	74.00^{c}±0.148	0.10^{d}±0.000	5.26^{b}±0.127	5.46^{a}±0.027	15.19^{b}±0.028
E	71.79^{d}±0.014	0.12^{c}±0.008	5.35^{ab}±0.000	5.36^{a}±0.000	17.38^{a}±0.014

Values are means ± standard deviation of triplicate samples. Mean values bearing different superscript in the same Column differ significantly (p<0.05)

Key: A=banga sauce unblanched, B=banga sauce blanched for 10min at 100°C, C= banga sauce blanched for 15min at 100°C, D= banga sauce blanched for 20min at 100°C, E= banga sauce blanched for 25min at 100°C.

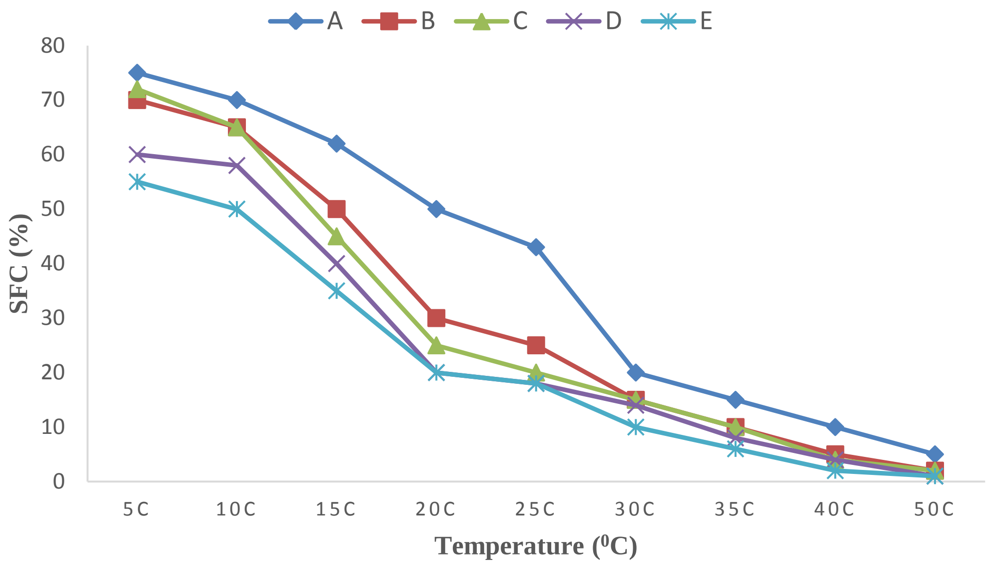

Fig. 2. Solid fat content – temperature profile of 'banga' sauce

Melting point, viscosity and density ranged from 32.31 – 36.44°C, 32.00 – 35.00 cSt and 0.9200 – 0.9968 g/cm^2, respectively. Melting point of the unblanched sample was significantly ($p<0.05$) higher, followed by the blanched for 15 min (sample C). Melting point is an indication of the temperature at which the fat softens or becomes sufficiently fluid to slip or flow [23]. Viscosity and density of the unblanched sample were significantly higher. Viscosity and density of the banga sauce decreased significantly with increase in blanching time. The viscosity of fat is its resistance to flow. It increases with the molecular weight of the oil and decreases with increasing unsaturation and high temperature [23]. Density gives information on the weight of the fat and the solid content at a specified temperature [23]. Density of the banga sauce was higher than density of crude palm oil given by earlier researchers [23].

3.3 Solid Fat Content (SFC)

The SFC is the amount of fat crystals in the banga sauce, and is responsible for many product characteristics, including general appearance, ease of packing, organoleptic properties, oil exudation and lubrication [28]. It also influences plasticity of edible oil product [29]. As shown in Fig. 2, the SFC of unblanched banga sauce was significantly high (75%) at refrigeration temperature (5°C), with significantly lower value of 55% seen in sample E. SFC of the samples at 25°C ranged from 18 – 43%. SFC at 22 - 25°C determines the product's stability and resistance to oil exudation at room temperature; a value of not less than 10% is essential to prevent oiling off [30]. At temperature range of 33–38°C, the SFC values influences the ''mouth feel'' or waxy sensations that are induced by the fat. SFC of 5 -3% is desirable at this temperature range [30]. The blanched banga sauce all fell within the preferred solid fat range.

3.4 Sensory Properties

As shown in Table 3, the sensory properties determined were appearance, colour, taste, aroma, thickness and overall acceptability. Appearance and colour scores ranged from 7.50 – 7.64 and 6.35 – 7.65, respectively. Colour and appearance are important sensory attributes which affect the perception of other attributes, such as aroma, taste and flavour [31]. There was no significant difference ($p>0.05$) in the appearance rating for samples A, B and C. Colour rating for the samples were also not significantly different ($p>0.05$). Taste scores for samples B and C were significantly higher ($p<0.05$) followed by sample E. Thickness score for unblanched banga sauce (sample A) was higher (8.10); this value was however, not significantly different from others. Overall acceptability scores ranged from 7.49 – 7.81, with sample C given higher value, though not statistically difference.

Table 2. Physicochemical properties of banga sauce produced from fresh oil palm fruits

Sample	PV (mEq/kg)	IV (g/100g)	SV (mgKOH/g)	FFA (%)	Melting Point (^0C)	Viscosity (cSt)	Density (g/cm^3)
A	$2.00^a±0.000$	$23.57^a±0.020$	$81.63^a±0.072$	$0.40^a±0.000$	$36.44^a±0.011$	$35.00^a±0.020$	$0.9968^a±0.010$
B	$2.08^a±0.015$	$23.39^a±0.000$	$81.62^a±0.006$	$0.36^c±0.002$	$34.23^b±0.000$	$34.02^b±0.000$	$0.9441^b±0.000$
C	$2.11^a±0.000$	$23.46^a±0.007$	$81.60^a±0.044$	$0.38^b±0.001$	$33.60^c±0.011$	$32.86^c±0.017$	$0.9372^{bc}±0.001$
D	$2.00^a±0.000$	$23.56^a±0.042$	$81.56^a±0.007$	$0.36^c±0.001$	$32.57^d±0.001$	$32.64^c±0.012$	$0.9286^c±0.002$
E	$2.02^a±0.008$	$23.50^a±0.085$	$81.61^a±0.000$	$0.34^d±0.000$	$32.31^d±0.001$	$32.00^d±0.005$	$0.9200^d±0.001$

Values are means ± standard deviation of triplicate samples. Mean values bearing different superscript in the same Column differ significantly ($p<0.05$)

Key: A=banga sauce unblanched, B=banga sauce blanched for 10min at 100^0C, C= banga sauce blanched for 15min at 100^0C, D= banga sauce blanched for 20min at 100^0C, E= banga sauce blanched for 25min at 100^0C. PV=peroxide value, IV=iodine value, SV=saponification value, FFA=free fatty acid.

Table 3. Sensory properties of 'Banga' sauce produced from fresh oil palm fruits

	Samples				
Parameters	**A**	**B**	**C**	**D**	**E**
Appearance	7.64^{a}±0.062	7.60^{a}±0.012	7.60^{a}±0.062	7.52^{b}±0.002	7.50^{b}±0.001
Colour	7.55^{a}±1.731	7.55^{a}±1.031	7.55^{a}±1.001	7.65^{a}±0.530	6.35^{ab}±1.705
Taste	7.20^{d}±0.042	8.00^{ab}±0.918	8.35^{a}±0.587	7.20^{d}±0.142	7.85^{c}±0.026
Aroma	7.65^{d}±0.033	7.63^{d}±0.968	7.75^{c}±0.851	7.90^{b}±0.933	7.95^{a}±0.081
Thickness	8.10^{a}±1.000	7.85^{a}±1.040	7.80^{a}±0.240	7.80^{a}±1.200	7.80^{a}±0.200
Overall Acceptability	7.63^{a}±1.476	7.73^{a}±0.165	7.81^{a}±1.140	7.61^{a}±1.356	7.49^{ab}±1.174

Values are means ± standard deviation of triplicate samples. Mean values bearing different superscript in the same row differ significantly (p<0.05)

Key: A=banga sauce unblanched, B=banga sauce blanched for 10min at 100°C, C= banga sauce blanched for 15min at 100°C, D= banga sauce blanched for 20min at 100°C, E= banga sauce blanched for 25min at 100°C

4. CONCLUSION

Findings from this work showed that moisture content of banga sauce decreased significantly with increase in blanching time. Difference in blanching time does not significantly affect the protein content of the sauce samples. Variations of blanching time do not significantly affect the peroxide value, iodine value and saponification value of the sauce. However, melting point, viscosity, density and solid fat content decreased significantly with increase blanching time. Solid fat content (SFC) of banga sauce produced from blanched fruits all fell within the desired solid fat range of 3 – 5% at 35 – 40°C. Taste scores for samples B and C were significantly higher followed by sample E. Effect of storage condition and time on the physicochemical and microbio-logical quality of blanched banga sauce shall be evaluated in subsequent paper.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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