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New Product Development from Tigernut (*Cyperus esculentus*) and Their Sensory, Proximate and Microbiological Evaluation

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Abstract: Tigernut tubers were processed in different ways to formulate two new products: product 1-Orange Tigernut Beverage (OTB) and product 2 - Tigernut Drink (TD). OTB was formulated from a blend of Orange Juice (OJ) and Tiger Nut Milk (TM) by substitution at ratio (OJ:TM) 100:0, 80:20, 60:40, 50:50, 40:60, 20:80 and 0:100. TD was formulated by drying tigernut tuber (8% moisture) and milling to obtain a powder. Spices were added. TD samples were obtained by reconstituting the powdered tigernut with cold water at a concentration of 5, 10, 15, 20 and 25% (w/v). The samples were evaluated for their sensory, proximate composition and microbiological status. Significant differences ($p<0.05$) existed between samples under various parameters. All the samples of OTB were highly acceptable but the sample (OJ:TM) 40:60 received the highest (8.3) over all acceptability. In TD, reconstituting the sample from 20 to 25% (w/v) was most (8.3-8.6) acceptable. Carbohydrate (38-50%) and moisture (39-60%) were quantitatively the major component of OTB. The samples were deficient in crude fiber. Samples (OJ:TM) 40:60 and 20:80 with carbohydrate (46%), protein (2%), ash (2-3%) and fat (3-4%) had the highest nutrient values. The reconstituted TB sample of 25% (w/v) had the highest (carbohydrate 46%, fat 22%, Ash and protein 2% respectively) nutrient level with carbohydrate, fat and moisture forming its major component. Crude fiber in TB was higher than that in OTB. A direct relationship existed between the microbial content of OTB and the rate of substitution. Microbial content ranged from no growth to 10^2 cfu/ml, which was not critical to the wholesomeness of the products. The TD samples showed no microbial growth thereby confirming the wholesomeness of the samples.

Key words: Product development, tiger nut, sensory characteristics, proximate composition, microbiological status

INTRODUCTION

Tigernut is a tuber that is grown in the soil. It has a dimension ranging from 6-10 mm and occurs in different varieties. The colour is brown and has a sweet flavour when eaten. Tigernut has been used extensively mainly for human consumption in Spain (Mason, 2008; Tigernuts Traders, 2009). Tigernuts are prepared and eaten cold as snacks. The milk can be extracted, treated and bottled. The flour is used to make cakes and biscuits and the oil is used for cooking (Wise, 2009). In United Kingdom, tigernut is superb bait for carp fishing (Wise, 2009). In Nigeria, the utilization of tigernut is highly limited in spite of the fact that tigernut is cultivated widely in the Northern part of the country. Tigernuts are eaten raw mainly as snacks or fried and eaten mixed with roasted groundnuts (Abaejoh *et al*., 2006). Kofi (1990) reported that sweetened tigernut extract are bottled and sold in Ghana.

Recently, there is awareness for increased utilization of tigernut (Belewu and Abodunrin, 2006; Belewu and Belewu, 2007; Ade-Omowaye *et al*., 2008; Ukwuru *et al*., 2008). Tigernuts are valued for their highly nutritious starch content, dietary fibre and carbohydrate (Umene and Enebeli, 1997) and are rich in sucrose (17.4-20.0%), fat (25.5%), protein (8.0%) (Kordyias, 1990; Temple *et al*., 1990). Tigernut is also rich in mineral content such as sodium, calcium, potassium, magnesium, zinc and traces of copper (Omode *et al*., 1995; Oladele and Aina, 2007). The dietary fibre content of tigernut is effective in the treatment and prevention of diseases such colon cancer, coronary heart diseases, obesity, diabetes and gastro-intestinal disorders (Anderson *et al*., 1994). Tigernut tubers are diuretic and can be used as stimulant and tonic (Chopral *et al*., 1986) and in the treatment of flatulence, indigestion, diarrhea, dysentery and excessive thirst (Chevalier, 1996). In addition, tigernut has been demonstrated to contain higher essential amino acids than those proposed in the protein standard by FAO/WHO (1995) for satisfying adult needs for protein (Bosch and Alegna, 2005). Researchers have developed phyto milk of acceptable quality from tigernut tubers (Abaejo *et al*., 2006; Ukwuru *et al*., 2008). Possible industrial application of tigernut tubers has also been investigated (Oderinde and Tahir, 1988). Tigernut tubers can be processed in different ways to obtain different products.

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These products are of high nutritional values and economic potentials, hence deserve a greater attention than it is currently given. As a crop that is grown widely in Nigeria, its availability is guaranteed. What is currently militating against the utilization of tigernut is the little awareness of the importance of this plant. The following are possible derivatives of tigernut: flour, milk, oil, cake, cream cheese, chocolate, biscuits, cookies, etc. The objective of this research was to develop new products from tigernut tubers in other to increase the utilization of tigernut.

MATERIALS AND METHODS

Source of materials: Tigernut (yellow variety) and oranges were obtained from Ega market in Idah, Kogi State, Nigeria. The materials were sorted and cleaned of all foreign materials.

Sample preparation

Product 1: Orange-Tigernut Beverage (OTB): Oranges were peeled, washed and cut. The juice was extracted with the aid of an extractor and filtered to obtain a clear Orange Juice (OJ). Tigernut tubers were blended into slurry using a warring blender (Model Philips) and dissolved in boiled water (1 kg tigernut/1000 cm^3 of water) to a homogenous mixture. The mixture was filtered using a muslin cloth. The filtrate obtained-Tigernut Milk (TM) - was measured and packaged in a 500 ml sterile bottle. OJ and TM were mixed at varying proportions (OJ:TM) 100:0, 80:20, 60:40, 50:50, 40:60, 20:80 and 0:100, to obtain the final product (OTB).

Product 2: Tigernut Drink (TD): Clean tigernut tubers were dried in an oven (Gallenkamp) at 60°C for 24-48 h to a moisture content of 8±1% and milled into a fine powder. The powder was sieved using a 10 mesh sized seive to obtain a flour. The flour was spiced with ginger and garlic (1 g/20 g w/w spice: tigernut flour) to enhance flavour and taste. The flour was packaged in an air-tight container. Flour samples were reconstituted in cold water in increasing solute concentration from 5, 10, 15, 20 and 25% (w/v) and designated as samples A-E respectively of TD.

Analysis: Sensory analysis was carried out according to the method described by Iwe (2002). The samples were coded and served chilled to 10 semi-trained panelists. The panelists were asked to indicate their preference using a 9-point hedonic scale for taste, colour, mouth feel, aroma and overall acceptability. Extremely good and extremely poor were ranked 9 and 1 respectively. The proximate composition-protein, moisture, crude fibre, ash, fat and carbohydrate were determined according to standard methods (AOAC, 1995). An aerobic plate count was carried out according to the method reported by Collins and Lyne (1979). The samples were serial diluted and an aliquot was plated in duplicate plates of plate count agar for bacteria and potato dextrose agar for moulds. The plates were incubated at 37°C, 24 h and 25°C, 3 days for bacteria and moulds respectively. Counts were carried out on plates containing 30-300 colonies using a colony counter and expressed as colony forming unit (cfu).

Statistical analysis: Samples were determined in triplicate. The data were subjected to Analysis of Variance (ANOVA) and Turkey's test was used for comparison of means. Significance was accepted at $p = 0.05$.

RESULTS AND DISCUSSION

Sensory characteristics: Table 1 shows the mean sensory scores for product 1(OTB). All the samples were highly rated in their sensory attributes including their overall acceptability. Significant differences ($p<0.05$) however existed among sample attributes. OTB sample 40:60 (OJ:TM) was rated highest in terms of taste, mouth feel and overall acceptability. This rating was higher than that of the reference samples 100:0 and 0:100 (OJ:TM). The sample 20:80 was rated highest in terms of colour while sample 80:20 was rated highest in aroma. Although the reference samples had higher ratings than the test samples in terms of colour and aroma, the difference was only marginal. The sample 50:50 (OJ:TM) received the lowest score in taste, colour and mouth feel. Sample 40:60 (OJ:TM) was significantly different ($p<0.05$) from the other samples in its overall acceptability.

Table 2 presents the mean sensory scores for product 2 (TD). The product was also highly acceptable especially as from 15-25% (w/v) reconstitution. Acceptance of this product appeared to increase with increasing concentrations of reconstitution up to 20% (w/v). Significant differences existed among samples when considered in terms of their sensory attributes. Sample reconstitutions of 20-25% (w/v) were competitively accepted. Reconstituting up to 25% (w/v) had the most acceptable taste and colour while up to 20% (w/v) had the highest mean scores for mouth feel and overall acceptability.

Proximate composition: The proximate composition of product 1 (OTB) is shown in Table 3. Carbohydrate, in addition to moisture, was quantitatively a major component of the beverage. The beverage samples were fairly rich in fat, protein and ash. Crude fibre was sparsely present. An observable trend was that carbohydrate content increased with increase in tigernut substitution. Several workers have confirmed the presence of high carbohydrate content in tigernut

Table 1: Mean sensory scores for product 1: Orange Tigernut Beverage (OTB)

	Sample (OJ:TM) ratio						
Parameter	100:0	80:20	60:40	50:50	40:60	20:80	0:100
Taste	7.3±0.5[a]	7.6±0.6[b]	6.2±0.5[a]	5.3±0.4[c]	8.6±0.6[b]	8.1±0.6[b]	6.8±0.5[c]
Colour	8.5±0.6[b]	8.0±0.6[b]	6.4±0.5[c]	6.1±0.5[c]	7.0±0.5[c]	8.0±0.6[b]	8.5±0.6[b]
Mouth feel	6.3±0.5[d]	5.5±0.5[d]	5.1±0.4[e]	4.2±0.4[e]	7.5±0.5[d]	7.0±0.5[d]	6.8±0.5[d]
Aroma	7.6±0.6[b]	7.3±0.5[a]	6.0±0.5[a]	5.2±0.4[c]	5.1±0.4[c]	5.1±0.4[c]	4.1±0.4[c]
Overall acceptability	6.4±0.5[a]	7.3±0.5[a]	7.0±0.5[a]	7.4±0.5[a]	8.3±0.6[b]	7.2±0.5[a]	5.3±0.4[d]

Mean±SD with different superscript along the same row are significantly different ($p<0.05$). OJ = Orange Juice, TM = Tigernut milk

Table 2: Mean sensory scores for product 2: Tigernut Drink (TD)

	Sample (% w/v)				
Parameter	5	10	15	20	25
Taste	4.5±0.3[a]	6.3±0.5[b]	6.9±0.5[b]	7.2±0.5[b]	8.3±0.6[c]
Colour	5.4±0.3[b]	5.6±0.5[c]	7.2±0.5[c]	7.4±0.5[c]	7.6±0.6[d]
Mouth feel	4.0±0.3[c]	5.2±0.3[c]	6.3±0.5[d]	7.9±0.5[d]	7.0±0.5[d]
Aroma	4.3±0.3[e]	4.6±0.3[e]	4.6±0.3[e]	7.4±0.5[a]	7.4±0.5[a]
Overall acceptability	4.2±0.3[b]	5.4±0.3[b]	6.0±0.5[d]	8.6±0.6[e]	8.3±0.6[e]

Mean±SD with different superscript along the same row are significantly different ($p<0.05$)

Table 3: Proximate composition of product 1: Orange Tigernut Beverage (OTB)

Sample	Proximate composition (%)					
(OJ:TM)	Moisture	Fat	Protein	Ash	Crude fibre	Carbohydrate
100:0	60.0[a]	0.8[b]	0.6[d]	0.4[b]	0.05	38.1[a]
80:20	56.6[a]	1.2[b]	0.7[d]	0.8[b]	0.04	40.7[a]
60:40	53.5[a]	1.4[b]	1.4[b]	1.7[c]	0.02	42.0[a]
50:50	50.4[a]	1.8[c]	1.6[c]	2.0[c]	0.02	44.2[a]
40:60	47.1[b]	2.6[c]	2.3[c]	2.2[c]	0.01	45.8[b]
20:80	45.1[b]	3.6[d]	2.4[c]	2.6[c]	0.01	46.3[b]
0: 100	38.6[b]	4.8[d]	2.7[c]	3.5[d]	0.01	50.4[c]

Mean±SD with different superscript along the same column differ significantly ($p<0.05$). OJ = Orange Juice, TM = Tigernut Milk

Table 4: Proximate composition of product 2: Tigernut Drink (TD)

Reconstituted	Proximate composition (%)					
sample (% w/v)	Moisture	Fat	Protein	Ash	Crude fibre	Carbohydrate
5	50.3[a]	9.0[b]	1.2	0.3	1.2	38.0[a]
10	41.4[a]	15.0[b]	1.6	0.6	1.4	40.0[a]
15	33.0[b]	18.0[b]	1.8	1.5	1.7	44.0[b]
20	29.7[b]	20.3[b]	2.1	1.8	1.9	44.2[b]
25	26.0[b]	21.8[c]	2.3	2.0	1.9	46.0[b]

Mean with different superscript in the same column differ significantly ($p<0.05$)

(Ade-Omowaye *et al.*, 2008). The Tigernut Traders (2009) of Valencia, Spain, have reported that tigernut has an energetic value of 400 kcal/100 g. Processing however affected the crude fibre content of the samples as they were very low as against the high crude fibre content of the tigernut tubers. The test samples 40:60 and 20:80 (OJ:TM) had the highest (46%) carbohydrate content while the sample 20:80 (OJ:TM) recorded the highest fat, protein and ash contents.

Table 4 presents the proximate composition of product 2 (TD). During reconstitution, increase in sample concentration resulted in corresponding increases in fats, protein ash, crude fibre and carbohydrate contents. Moisture however decreased under this same condition. Carbohydrate and fats were major components of this product. Crude fibre was more evidently present in this product as against the quantity in product 1 samples. Values of protein, ash and crude fibre in all the reconstituted samples did not differ significantly ($p>0.05$). Significant differences were observed in carbohydrate, fats and moisture values. Reconstituting the drink by 25% (w/v) recorded the highest levels of nutrients. Earlier researchers have confirmed high levels of various nutrients in tigernut (Eteshola and Oraedu, 1996; Sowonola *et al.*, 2005). These nutrients were not significantly affected during processing.

Table 5: Aerobic plate count (cfu/ml) of product 1: Orange Tigernut Beverage immediately after production

Sample (OJ:TM)	Bacteria	Moulds
100:0	NG	4.6×10^2
80:20	NG	3.5×10^1
60:40	NG	1.2×10^1
50:50	2.7×10^1	1.2×10^1
40:60	4.8×10^1	NG
20:80	4.9×10^2	NG
0: 100	6.7×10^2	NG

OJ = Orange Juice, TM = Tigernut milk, NG = No Growth

Table 6: Aerobic plate count (cfu/ml) of product 2: Tigernut drink immediately after production

Reconstituted sample (% w/v)	Bacteria	Moulds
5	NG	NG
10	NG	NG
15	NG	NG
20	NG	NG
25	NG	NG

NG = No Growth

Aerobic plate count: The aerobic plate count of product 1 (OTB) is presented in Table 5. A positive and negative linear relationship in terms of bacteria and mould contamination respectively existed in the product samples with increasing TM substitution. Tigernut milk is imitation milk similar in composition with animal milk. Its rich nutrient and moderate pH makes it an excellent culture medium for the growth of microorganisms especially bacteria. Hence, the more the TM that was available, the more likely the bacterial contamination. This can serve as a critical control point in the processing of tigernut milk. On the other hand the moulds tolerate low pH levels. As an acid food, orange juice where present, is likely to have more mould contamination than bacteria. The bacteria and mould contaminants in the test samples ranged from no growth to 10^2 (max) cfu/ml. The level of contamination was not critical to the microbiological status of the beverage samples after production. Milk products are however easily perishable because contaminating bacteria may multiply rapidly and render it unfit for human consumption. Bacterial growth can be retarded by refrigeration. Considering the fact that refrigeration may not always be feasible due to economic or technical reasons, the FAO/WHO Expert Panel on Milk Quality concluded that the use of hydrogen peroxide may be an acceptable alternative. However the difficulty in controlling its use may be a drawback (FAO/WHO, 2000). The search for a method such as the chemical method for preserving milk will be of great value under certain conditions. Recent basic applied research has demonstrated that one of these systems, the lactoperoxidase/thiocyante/hydrogen peroxide system can be used successfully for this purpose (FAO/WHO, 2000).

Table 6 presents the aerobic plate count of product 2 (TD). There was no microbial growth in any of the reconstituted samples. As a dehydrated product, the low moisture content inhibited the growth of microorganisms. The critical control point here is to reconstitute with clean water and make sure that the dehydrated sample does not absorb moisture.

Conclusion: Two new products were developed from tigernut tubers. These were Orange Tigernut Beverage (OTB) and Tigernut Drink (TD). OTB was a blend of orange juice and tigernut milk. Although all the samples were highly acceptable, OTB sample ratio 40:60 (OJ:TM) was most acceptable. That same sample and 20:80 (OJ:TM) had the highest proximate composition values. All the OTB samples maintained good microbiological status. The beverage can be stored by refrigeration to retard microbial growth. On the other hand, TD was a dehydrated sample. Reconstituting it with cold water from 20-25% (w/v) was highly acceptable. The product had good proximate composition values and were microbiologically wholesome. The drink can be stored in an air-tight container in a cool dry place.

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