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Tiger Nut (*Cyperus esculentus*) Milk Powder: Effects of Preservatives on Quality Characteristics

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Abstract

Tiger nut milk *(Kunun aya)* is a traditional fermented non-alcoholic beverage widely consumed in northern parts of Nigeria especially during the dry season. The short lifespan of tiger nut milk beverage affects its large scale production and profitability. Big yellow tiger nuts were thoroughly washed with warm water, air-dried and then grinded into powder. The powder milk was then, divided into four portions and subjected to the following treatments; 0.05 g% sodium benzoate, 0.05 g% gelatin, a combination of 0.05 g% of gelatin and sodium benzoate and a fresh tiger nut powder as a control. The samples were stored at room temperature (28 ± 2 ºC) and the influence of added preservatives on nutrients and sensory quality of the samples were evaluated every week for a duration of six (6) weeks. The protein content increased slightly after storage, vitamin C & E contents of the treated milk samples were found to be significantly (P<0.05) different compared with the control sample after storage. The mineral elements of the treated milk samples were not significantly (P>0.05) different with the control sample at the respective storage time. The sensory quality characteristics and general acceptability of the tiger nut milk powder were not statistically affected by addition of preservatives and storage time. This study successfully processed tiger nut into milk powder with good acceptability.

Keywords: *Milk powder, preservation, quality, sensory score, tiger nut*

Introduction

Tiger nut (*Cyperusesculentus*) is a monocotyledenous plant that belongs to the family *cyperaceae* which is made up of over 4000 species (Ekeanyanwu *et al.,* 2010). It is locally called '*aya'* in hausa, '*akiawusa'* in igbo, and '*ofio'* in Yoruba. It is a perennial grass-like plant with spheroid tubers, pale yellow cream kernel surrounded by a fibrous sheath, it grows in wet areas and often occurs as a weed especially on farm lands used for cultivation of vegetables (Webster *et al.,* 2001). Its common names include; as yellow nut sedge, earth or ground almonds, "*souchet"* in French, "*ermandeln"* in German and "*chufa"* in Spanish (Abaejoh *et al.,* 2006). Tiger nut is found wild and cultivated in Africa, South America, Europe and Asia. Tiger nuts grow in the wild, along rivers and are cultivated on a small scale by rural farmers mostly in the northern states of Nigeria. Tiger nuts are edible, sweet, nutty, flavored tubers which contain protein, carbohydrate, sugars, and lots of oil and fiber (FAO, 2002). Grossman and Thomas (1998) reported that tiger nuts have been cultivated for food and drink for men and planted for hogs for many years in Spain and that the lovely milky elixir is served in health Spas, Pubs, and restaurants as a refreshing beverage (competing successfully with other soft drinks). Its tubers are said to be aphrodisiac, Carminative, diuretic, stimulant and tonic (Chopra *et al.,* 1986; Chevallier, 1996). Tiger nut has also been reported to be used in the treatment of flatulence, Indigestion, diarrhea, dysentery and excessive thirst (Chevallier, 1996). Unfortunately, despite these potentials in tiger nut it has been a neglected crop in Nigeria. This probably may be due to inadequate knowledge on its production, utilization and nutritional value. Tiger nut could provide a basis for rural industries in Africa. It is an important food crop for certain tribes in Africa, often collected and eaten raw, baked as a vegetable, roasted or dried and ground to flour. The grounded flour is mixed with sorghum to make porridge, ice-cream, sherbet or milky drink. It is mostly consumed raw as snack without knowledge of the food and nutritional quality (FAO, 2002). It has also been found to possess good therapeutic quality (Moore, 2004). Moore (2004) stated that "the expansion of tiger nut milky drinks will significantly help the research linking tiger nut milk to healthier cholesterol levels and other nondairy manufacturers. This could also gain a boost from an increased consumer interest in health foods. Tiger nut milk must be consumed within 2-24 hours at 4ºC-10ºC due to its poor shelf life (Akoma *et al.,* 2006), also the high water content coupled with crude method of production and packaging under improper sanitary conditions predispose tiger nut milk to microbial contamination. Although many women have developed the skills for commercial production of the milk (Musa and Hamza, 2013), preserving and extending the shelf life of tiger nut milk is a great challenge. Nwobosi *et al.* (2013) and Ibrahim *et al.* (2016a) have made an attempt to delay its spoilage by addition of some natural preservatives and by some physical methods such as short temperature long time pasteurization, refrigeration, sterilization, ultraviolent light, freezing and sodium benzoate treatments but with little success that could allow long distance transportation of the product and lengthened the storage time. This study was therefore aimed at processing tiger nut milk into powder form and determine the effects of addition of preservatives, and storage time on the nutritional and sensory characteristics of the tiger nut milk powder.

Materials and Methods

Chemicals and Reagents
All chemicals and reagents used were of analytical grades

Sample collection and preparation
Dry tiger nut (big yellow) was purchased from Sokoto central market, it was sorted and washed thoroughly with cooled boiled water, it was allowed to air dry and then grinded into powder.

Experimental design
Tiger nut milk powder was divided into four (4) portions and subjected to the following treatments:
Group 1: Tiger nut milk powder without preservative (TMP; Control).
Group 2: Tiger nut milk powder plus 0.54 g sodium benzoate (TMPS).
Group 3: Tiger nut milk powder plus 0.54 g of gelatin (TMPG).
Group 4: Tiger nut milk powder plus 0.54 g gelatin and 0.54 g sodium benzoate (TMPGS).
Each of the group was divided into six (6) places, and kept in an air tight container. These samples were analysed for six (6) weeks.

Milk preparation
One hundred and eighty gram (180 g) of the sample powder was placed in a plastic container and 540 ml of distilled water was added, the mixture was stirred gently and then sieved

Sensory evaluation
Undergraduate students of Usmanu Dan fodiyo University Sokoto who were familiar with the consumption of tiger nut milk assessed the sensory quality of the milk samples. A five points hedonic scale was used in the assessment, where 5 scores ‘extremely like’ and 1 scores ‘extremely dislike’ (Harry and Heymann, 2010). The judges rated the milk samples based on colour, odour, taste, mouth feel and general acceptability.

Determination of crude protein
The crude protein content of the powder samples were determined by the micro-Kjeldahl standard method of AOAC (2005).

Determination of vitamins
The vitamin C and E of the tiger nut milk powder preserved with preservatives and the control samples were determined by spectrophotometric method described by Rutkwoski *et al.* (2005).

Determination of mineral elements
Potassium and sodium ions were determined using flame photometer, calcium and magnesium ions were determined using EDTA titration method and phosphorus was determined using spectrophotometric method (Black, 1965).

Statistical analysis
All data were expressed as Mean ± Standard Deviation (SD). Data was analyzed using One-way analysis of variance (ANOVA), the comparisons between more than two groups was performed using Kruskal-Wallis one-way analysis of variance, followed by the Bonferroni multiple comparisons test. The graph pad software instant 3-software (San Diego, USA) was used to perform the statistical analysis. Differences in Mean were considered to be significant at ($P < 0.05$).

Results and discussion

The crude protein content of tiger nut milk powder as affected by addition of preservatives and storage time is presented in Table 1. The crude protein content of the powder milk significantly increased as the storage time increase. However, no significant differences in the crude protein content of the preserved milk powder with the unpreserved one at the respective storage time. The percentage crude protein content obtained in this study falls within the values reported from previous studies of Ukwuru and Ogbodo (2011); Ibrahim *et al.* (2016b).
Vitamin C and E content of tiger nut milk powder as affected by addition of preservatives and storage time are presented in Table 2. There was a significant decreased in the vitamin C content of the milk powder as the storage time progress. Likewise, the vitamin C content of the preserved milk powder significantly decreased as compared with TMP at the respective storage time. Except for the week 6 preserved milk powder, which have significantly

higher vitamin C content when compared with week 6 TMP. The vitamin E content of the preserved and unpreserved tiger nut milk powder significantly increased as the storage time increase. Likewise, there are significant differences in the vitamin E content of the preserved samples as compared to TMP.

Table 1: Effects of storage time on crude protein of preserved tiger nut milk powder

Samples	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
TMP	5.60±0.50	6.31±0.31	6.79±0.28	6.56±0.39	7.17±0.28	7.17±0.28
TMPS	4.90±0.70	5.69±0.39	6.62±0.28	6.74±0.28	7.24±0.37	7.24±0.37
TMPG	5.60±0.50	6.43±0.28	6.31±0.37	6.93±0.28	7.61±0.37	7.61±0.37
TMPGS	5.10±0.70	6.55±0.28	6.37±0.39	6.62±0.39	7.36±0.39	7.36±0.39

Values are expressed as mean ± SD of triplicate, there is no significant difference at α = 0.05 compared to TMP at the respective storage time. TMP= Tiger nut milk powder without preservative; TMPS= Tiger nut milk powder plus 0.54 g sodium benzoate; TMPG= Tiger nut milk powder plus 0.54 g gelatin; TMPGS= Tiger nut milk plus 0.54 g gelatin and 0.54 g sodium benzoate.

Table 2: Effects of storage time on vitamin C and E content of preserved tiger nut milk powder

	Samples	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Vitamin C (mg/dl)	TMP	7.60±0.02	3.64±0.13	3.60±0.01	4.12±0.08	4.27±0.06	3.24±0.03
	TMPS	7.30±0.03*	3.24±0.01*	3.35±0.02*	3.75±0.03*	3.72±0.01*	3.87±0.01*
	TMPG	6.80±0.02*	3.38±0.01	3.38±0.01*	3.67±0.02*	3.89±0.01*	3.71±0.02*
	TMPGS	6.40±0.04*	3.17±0.01*	2.98±0.02*	3.46±0.01*	4.70±0.01*	4.15±0.03*
Vitamin E (mg/dl)	TMP	53.4±0.7	125.27±0.97	115.71±2.14	106.67±1.74	154.89±2.26	114.93±0.75
	TMPS	47.30±1.70*	111.04±0.74*	121.67±1.49*	126.67±0.79*	148.37±2.64	84.33±0.75*
	TMPG	57.30±2.00	93.21±0.97*	126.43±1.89*	120.23±0.79*	119.05±4.28*	122.24±2.62*
	TMPGS	40.40±1.40*	65.39±1.32*	110.24±1.49*	115.86±1.82*	110.78±1.56*	114.93±0.75

Values are expressed as mean ± SD of triplicate, values with * indicate significantly difference at α = 0.05 compared to TMP at the respective storage time. TMP= Tiger nut milk powder without preservative; TMPS= Tiger nut milk powder plus 0.54 g sodium benzoate; TMPG= Tiger nut milk powder plus 0.54 g gelatin; TMPGS= Tiger nut milk plus 0.54 g gelatin and 0.54 g sodium benzoate.

Table 3 presents the effects of storage time on mineral content of preserved tiger nut milk powder as compared to tiger nut milk powder without preservative. There was no significant changes in the mineral content of the preserved milk powder as compared to tiger nut milk powder without preservative. Except TMPGS at week one which was significantly higher than TMP at the same storage time.

Table 3: Effects of storage time on mineral content of preserved tiger nut milk powder

	Samples	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Potassium (mg/kg)	TMP	1026.67±141.89	1590±185.20	1433.33±152.75	1500±100	1533.33±152.75	1500±100
	TMPS	1266.67±57.73	1573.33±303.53	1466.67±305.51	1543.33±128.97	1600.00±200.00	1543.33±128.97
	TMPG	1276.67±150.40	1596.67±136.50	1433.33±152.75	1676.00±112.39	1500.00±200.00	1676.00±112.39
	TMPGS	1640. 00 ±163.71*	1620. 00 ±100.00	1700.00±200.00	1483.33±175.59	1766.67±152.75	1483.33±175.59
Sodium (mg/kg)	TMP	100.00±5.73	103.33±8.78	105.42±5.05	95.42±3.82	100.83±3.82	95.42±3.82
	TMPS	105. 00 ±5.00	100.00±7.50	105.83±3.15	88.33±3.82	102.50±5.00	88.33±3.82
	TMPG	105. 00 ± 5.00	103.33±3.82	102.50±5.45	89.58±4.02	97.50±2.50	89.58±4.02
	TMPGS	100.00±5.00	99.17±7.64	102.50±3.75	98.33±1.91	97.5±5.00	98.33±1.91
Calcium (mg/kg)	TMP	0.60±0.10	0.37±0.08	0.43±0.08	0.47±0.13	0.35±0.05	0.47±0.13
	TMPS	0.50±0.05	0.43±0.03	0.43±0.03	0.55±0.13	0.43±0.03	0.55±0.13
	TMPG	0.80±0.08	0.35±0.05	0.37±0.10	0.53±0.10	0.43±0.08	0.53±0.10
	TMPGS	0.75±0.10	0.37±0.10	0.33±0.03	0.47±0.03	0.35±0.10	0.47±0.03
Magnesium (mg/kg)	TMP	0.88±0.08	0.80±0.05	0.90±0.05	1.17±0.10	1.05±0.05	1.17±0.10
	TMPS	1.13±0.13	0.98±0.08	0.95±0.05	1.25±0.10	1.12±0.08	1.25±0.10
	TMPG	1.07±0.13	1.00±0.10	0.92±0.08	1.20±0.05	0.98±0.08	1.20±0.05
	TMPGS	0.92±0.08	1.03±0.13	0.93±0.10	1.13±0.08	1.03±0.10	1.13±0.08
Phosphorus (mg/g)	TMP	3.60±0.03	4.09±0.30	3.94±0.03	3.28±0.05	3.99±0.02	3.28±0.05
	TMPS	3.50±0.07	4.05±0.02	3.89±0.02	3.28±0.05	4.03±0.02	3.28±0.05
	TMPG	3.70±0.09	4.03±0.04	3.86±0.02*	3.17±0.03	4.00±0.02	3.17±0.03
	TMPGS	3.60±0.04	4.00±0.04	3.91±0.03	3.19±0.02	4.01±0.02	3.19±0.02

Values are expressed as mean ± STD of triplicate values with * indicate significantly difference at α = 0.05 compared to TMP at the respective storage time. TMP= Tiger nut milk powder without preservative; TMPS= Tiger nut milk powder plus 0.54 g sodium benzoate; TMPG= Tiger nut milk powder plus 0.54 g gelatin; TMPGS= Tiger nut milk plus 0.54 g gelatin and 0.54 g sodium benzoate.

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The sensory score of the effects of addition of preservatives to tiger nut milk powder was presented in Figure 1. There was no significant difference in the sensory score of preserved and unpreserved samples at the respective storage time.

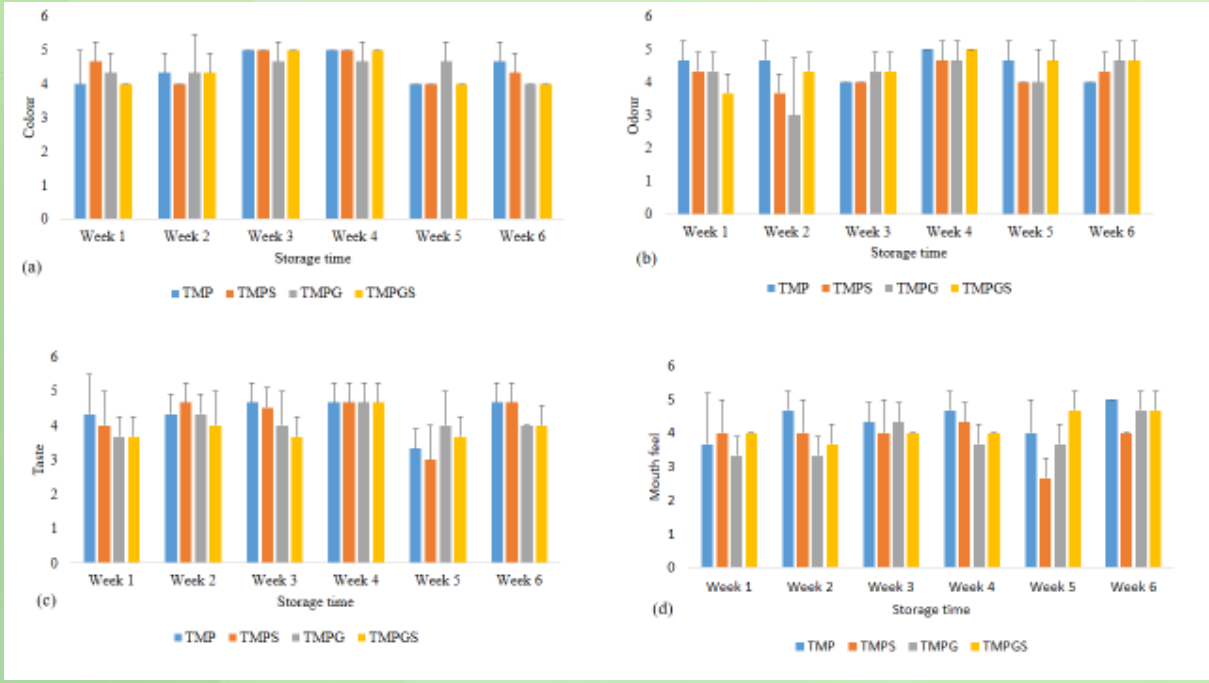

Figure 1: Effects of storage time on sensory score of preserved tiger nut milk powder.

Note: a): colour; b): odour; c): taste: d): mouth feel. Values are expressed as mean ± STD of triplicate. TMP= Tiger nut milk powder without preservative; TMPS= Tiger nut milk powder plus 0.54 g sodium benzoate; TMPG= Tiger nut milk powder plus 0.54 g gelatin; TMPGS= Tiger nut milk plus 0.54 g gelatin and 0.54 g sodium benzoate.

All the tiger nut milk powder had similar general acceptability score at their respective storage time as shown in Figure 2.

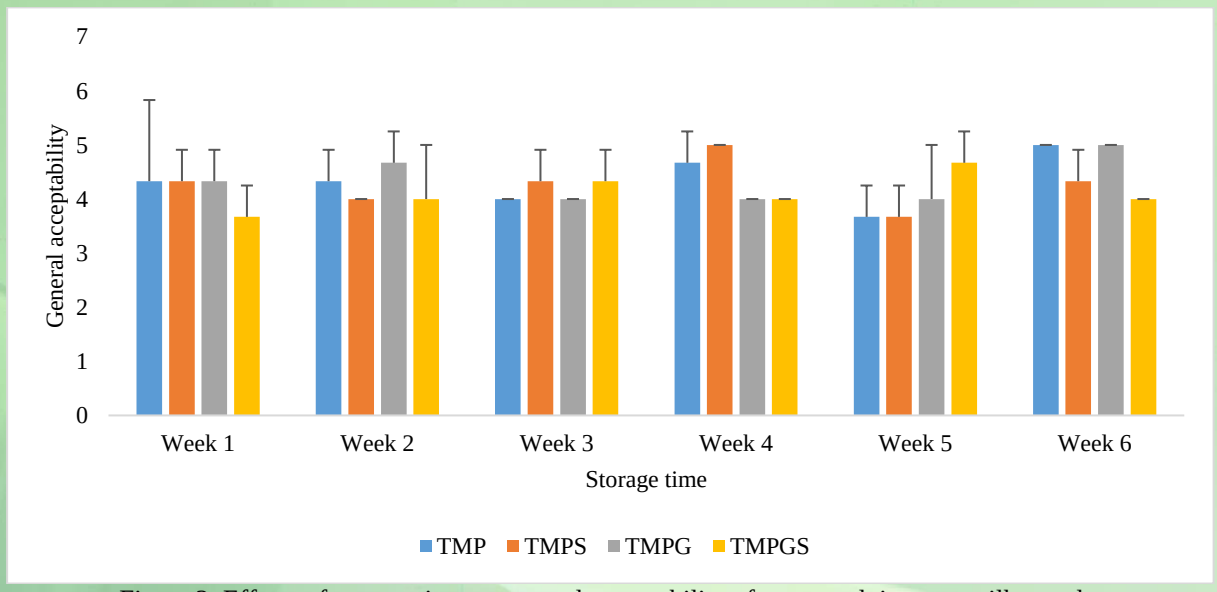

Figure 2: Effects of storage time on general acceptability of preserved tiger nut milk powder

The organoleptic properties of tiger nut milk produced from the treated samples and the control samples were found to be good and generally acceptable throughout the storage period. However, there was a significant difference at ($P<0.05$) on the general acceptability between the treated sample with a combination of 0.05% sodium benzoate and gelatin and the control sample after storage. This may be due to the combination of the two (2) preservatives which might have caused a deviation in the sensory attributes that the panelist are used to.

Conclusion

Tiger nut was successfully processed into tiger nut milk powder. Addition of preservatives to tiger nut milk powder have no significant effect on the crude protein, mineral elements and sensory quality. However, the vitamin C and E were significantly affected. Likewise, the storage time had more significant effect on the vitamin C and E of the milk powder.

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