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EFFECT OF GINGER POWDER ON THE QUALITY OF STORED ACHA BASED *KUNUN ZAKI*

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ABSTRACT
This study determined the effect of ginger addition on the physicochemical, microbiological, shelf life and sensory qualities of added ginger powder (1,2,3,4%) on *acha* based *kunun zaki*. *Acha Kunun zaki* was prepared according to standard methods incorporating ginger powder into *acha* flour to produce *acha kunun zaki* along with a control sample. The total solids (TS) content of the acha-ginger blend kunun zaki increased from 84.18 to 97.97% with increase in the added ginger powder (0-4%). The TS subsequently decreased from 80.58 – 68 .38, 86.51 – 74.39, 90.59 – 79.94, 90.89 – 80.38 and 90.92 -80.44% with increased in the storage duration (1-5days).The total soluble solids (TSS) content of the acha-ginger blend kunun zaki ranged from 10.49- 10.71 with added ginger powder and subsequently decreased from 10.91 - 10.43, 10.64 -10.40, 10.49 – 9.11, 10.61 - 10.17 and 10.49 - 10.27%, respectively, with increase in the storage duration. The total bacterial count of the acha-ginger blend kunun zaki decreased from 2.03 to 1.60cfu/ml with increase in the added ginger powder and subsequently increased from 2.03 - 15.65, 1.75 – 6.84, 1.65 – 6.34, 1.60 – 4.56 and 1.60 – 4.25cfu/ml with increase in duration of storage(1-5days).The total fungi count of the acha-ginger blend kunun zaki increased from1.0 to 1.60cfu/ml with increase(1-2%) addition of ginger powder and subsequently decrease to 1.05cfu/ml. However, the total fungal count increased from 1.0 – 5.70, 1.75 – 3.70, 1.60 – 2.90, 1.05 – 1.45 and 1.05 – 1.10cfu/ml, respectively, with increase in the storage duration (1-5day). *E. coli* was principally implicated in the samples.Acha-ginger blend kunun zaki is acceptable upto 4% level of added giger powder(average means scoresof 5.75) and upto to three days of storage(average mean scores of 5.05).
***Keywords**: Acha grain, kunun-zaki, ginger powder, quality*

INTRODUCTION

Kunun zaki is a cereal based non-alcoholic fermented beverage mostly consumed in the Northern part of Nigeria. It can be produced either from millet (*Pennisetumtypoidum*), Sorghum (*Sorghum bicolor*), or maize (*Zea mays*) Akoma *et al*., (2006). *Kunun-zaki* is a Hausa word meaning sweet beverage (Sengev *et al.,(*2010). It is consumed anytime of the day by both adults and children as a breakfast food drink. It is a refreshing drink usually used to entertain visitors; it also serves as an appetizer and is commonly served at social gathering (Amusa and Ashaye, 2009). Onuorah *et al*., (1987) reported *kunun* as being regarded as after meal drinks or refreshing drinks in rural and urban Centre's, it is sometimes used as a weaning drink for infants (Adebayo *et al*., 2009). It is nutritious than the carbonated beverages, thus contributing to daily nutrients intake of consumers (Inatimi, 2007).

Kunun-zaki is of low viscosity and has sweet sour taste with milky appearance (Adeyemi and Umar, (1994). Preparation methods vary amongst people's taste and cultural preferences. Production of *kunun-zaki* is still on small scale and the beverage is widely found in the local market and at resorts (Innocent *et al*., 2011). This non-alcoholic beverage is however becoming more widely accepted in several other parts of Nigeria, owing to its refreshing qualities (Amusa and Ashaye, 2009).

Generally, *kunun-zaki* production involves steeping of grains, wet milling, sieving and partial gelatinization of the slurry left overnight / few hours to produce the beverage. It is obtained after 5 days and could only be stored for another 3 days when refrigerated (Adeyemi and Umar 1994). Reduction in processing time and an alternative technology to produce safer and shelf stable powdered *kunun* drink that would be reconstituted when needed would help to improve the availability of this indigenous food drink and more convenient.

Acha or *Fonio* (*Digitaria exilis)* grains from recent works have proofed to be acceptable for production of *kunun zaki* (Amusa and Ashaye, 2009). Currently *Acha* is the most vital food material for millions of people in the world. Among the cereals, *Acha* is the most nutritious grain containing crude protein (7%) that is high in leucine (19.8%), methionine and cysteine (7%) and valine (5.8%) (Temple and Bassa,1991, Philip and Itodo 2006).). It has been reported that the methionine and cysteine in *Acha* supply sulphur and other compound required for normal body metabolism and growth while cysteine is a major constituent of the proteins that make up hair, nails, skin and is involved in major detoxification process in the body (Belton and John, 2002).

Acha is also reported to have lower glycemic index than sorghum, corn and white rice which are intermediary in glycemic indexes (Belton and John, 2002). *Acha* has the potentials to improve human nutrition, boost food security, foster development and support land use; being one of the world fastest growing cereals that can mature in three to four months (Seignobos and Tourneux, 2002) the crop can be relied upon in semi-arid areas where rain is scarce unreliable and on marginal or poor soils not suited to other crops. Industry for production of soft drinks which have in no little way affects the economy.

Nigeria, a developing Nation, has for long dependent on imported raw materials. In order to conserve foreign exchange, emphasis is now on the development of indigenous beverages and the country attention has begun to shift toward the local sourcing of raw materials for economic development (Obadina *et al.,* 2008). Many researchers have worked on the quality improvement and health benefit of *kunun zaki* but the outcomes are yet to meet the requirement. *Kunun zaki* because of its village technology approach of production has short shelf life and variation in the sensory qualities. Thus to a great extents of

this, affect the acceptability of *kunun zaki* in some communities. The aim of the study was to investigate the effect of added ginger on physicochemical, microbiological and sensory qualities of *acha kunun zaki*

MATERIALS AND METHODS

Materials

Acha (*Digetarialexillis*) grains were purchased from Wurukum market Makurdi, Benue State. Spices (ginger and potato) were purchased from a local market Kyado of Benue State, Nigeria.

Sample preparation

The standard method as described by Chowdhury *et al*., (2002) and Lim, *et al*. (2006) was used for the preparation of ginger powder. The fresh ginger root with skin was peeled, cut into slices and oven dried at 50^{o}C, milled, packed in a polyethylene pack and stored at 4^{o}C.

Production of *kunun zaki*

The modified method of Ayo *et al*., (2013) was adopted in the production of *kunu zaki*. One kilogram (1 kg) of cleaned *acha* grains were washed and steeped in clean water for 48 h. The grains were washed to remove stones and wet milled along with added 150g 0f potato echips (as substitute to sucros normally added) and spices (ginger substituted into the slury at 1, 2, 3, 4%). Two/third of the slurry was mixed with 1000 ML of boiling water and stirred to form a gel and allowed to cool for 3 h. The remaining one- third of the slurry was added to the gel, mixed with cold boiled water (500 ML) and left open to ferment for 12 h. It was then sieved with a muslin cloth and the filtrate bottled for analysis.

Method of analysis

Determination of Physical properties of acha-ginger *kunun zaki*

Total solid: Total solid was determined by evaporating 25 ML of *kunun zaki* in a boiling water bath which was followed by drying to constant weight in an oven at 130°C for 3hrs (Cavalcanti *et al*., 2008).

$$\%\text{Total solid} = \frac{\text{Dry weight} \times 100}{\text{Weight of sample}}$$

Total soluble solid content: The analysis of TSSC readings were performed by refractometry using the Abbe refractometer (PZO - RL1, Warszawa, Poland) (Cavalcanti *et al*., 2008).

Measurement of pH: The pH of each samples was determined at room temperature (20^{o}C) using a pH meter (TEC-2 pH meter; Tecnal, Sion Paulo sp Brazil) (Cavalcanti *et al.*, 2008).

Acidity of acha-ginger *kunun zaki*: The titrable acidity of the acha-garlic *kunun zaki* was determined by the methods described by Nwokoro (2012) and Chukwu and Hwanhlen *et al.,* (2011).

Microbial analysis

Total Microbial Count: The total microbial count was determined as described by Gaffa and Ayo (2002). Ten milliliter of each *kunun zaki* sample was thoroughly mixed in 90 mL sterile distilled water to obtain 10^{-1} dilution, from which further dilutions were made. One milliliter of appropriate dilutions was mixed with molten medium (45°C) using potato dextrose agar (PDA) for molds; malt extract agar (MEA) supplemented with streptomycin for yeast; MacConkey agar for coliforms; Nutrient agar (NA) for total viable bacteria; and Mannitol salt agar for *Staphylococcus*. Incubation period was 48 h at 37°C except for yeast and molds (25°C, 72 h). Determinations were carried out in duplicates and counts were expressed in logarithmic of colony- forming unit per mL of sample (log CFU/mL)

Bacterial Load: Spread plate technique as described by Palczar and Chan, (1997) was used. One (1 ml) milliliter of each sample was aseptically transferred to 9 ml of sterile water in a separate tube and mixed vigorously. One (1 ml) mililiter of the resulting mixture was transferred to 9 ml of sterile water in a separate tube. The process was continued until the 6th diluents (10^{-6}). Nutrient Agar (NA) was inoculated with a 0.1 ml of appropriately diluted *kunu-zaki* (10^{-6}) by spread-plating technique and incubated at 37˚C for 24 h. Colonies were counted and multiplied by the dilution factor.

$$\text{Bacterial load (cfu/g)} = N \times \frac{1}{V} \times D$$

Where:

N = Numbers of colonies counted.

V = Volume of inoculums D = Dilution factor

Fungi Load Count: The fungi count was determined as described by Gaffa and Ayo (2002). Potato Dextrose Agar was used for fungal load count using the spread plate technique. 0.1 ml of the 4th diluents was used and incubated 37˚C.

$$\text{Fungi load (cfu/g)} = N \times \frac{1}{V} \times D$$

Where:

N = Numbers of colonies counted.

V = Volume of inoculums D = Dilution factor.

Sensory evaluation

The *kunun zaki* samples were subjected to sensory evaluation for the attributes of appearance, viscosity, aroma, taste, and acceptability as described by Adeyemi and Umar (1994). A semi trained twenty member panel was used and scores were allocated to the attributes based on a 9 point hedonic scale ranging from 1 (dislike extremely) to 9 (like extremely).

Statistical analysis

Data were subjected to Analysis of variance and differences between means were evaluated by Duncan's multiple range test (DMRT) using SPSS software programme, version 10.01. Significant differences were expressed as $p < 0.05$.

RESULTS AND DISCUSION

Physical properties of *acha*/ginger *kunun zaki*

The results of the Total Solid (TS) contents of the *acha*-ginger based *kunun zaki* are shown in Table 1. The total solids (TS) content of the acha-ginger blend kunun zaki increased from 84.18 to 97.97% with increase in the added ginger powder (0-4%). The TS subsequently decreased from 80.58 – 68 .38, 86.51 – 74.39, 90.59 – 79.94, 90.89 – 80.38 and 90.92 -80.44% with increased in the storage duration (1-5days). The addition of ginger powder to acha based kunun zaki has a significance effect, $p<0.05$, on the total solid contents.The relative increase in TS with increase could be due to the added ginger powder. However, the decrease observed with storage duration could be due to the breaking down of the solids (including the soluble) by inherent microorganinsm for their feeding (Gaffa and Ayo 2002).

This study can be compared with that of Adejuyitan *et al.*, (2008) that reported 9.20 to 12.50% total solid content for *kunun zaki*. However, higher total solid had effect on consumer acceptability as it imparts texture to the beverage (Adejuyitan *et al.,* 2008). The result generally showed an

increased in the total solid with increased in the percentage of added ginger powder (1 to 4%). However there was decreased in the total solids with increased in the storage duration (1 – 5 days). The increased in the total solid with increased in percentage added ginger powder could be due to the solid content of the added ginger powder.

Table 1: Total solid content (TSC) of *acha-ginger blend kunun zaki*

Storage (days)	Samples (%)				
	A	B	C	D	E
1	84.58±0.01^{a}	86.51±0.01^{a}	90.59±0.01^{a}	90.89±0.01^{a}	90.97±0.01^{a}
2	82.59±0.01^{b}	84.52±0.01^{b}	85.51±0.01^{b}	90.51±0.01^{b}	90.51±0.01^{b}
3	74.75±0.01^{c}	76.85±0.01^{c}	86.75±0.01^{b}	88.52±0.01^{ab}	89.39±0.01^{c}
4	60.83±0.01^{d}	76.79±0.01^{c}	84.47±0.01^{bc}	88.97±0.01ab	87.52±0.01^{d}
5	60.38±0.01^{e}	74.39±0.01^{d}	79.94±0.01c	80.38±0.01c	80.44±0.01^{d}

*Values are means ± standard deviation of 2 replications. Means with different superscripts within the same column are significantly different from each other at $p<0.05$.
Ratio of acha:ginger: A= 100:0, B = 99:1,C = 98:2,D =97:3, E= 96:4

The total soluble solids (TSS) content of the acha-ginger blend kunun zaki ranged from 10.49- 10.71 with added ginger powder and subsequently decreased from 10.91 - 10.43, 10.64 -10.40, 10.49 – 9.11, 10.61 - 10.17 and 10.49 - 10.27%, respectively, with increase in the storage duration as showed in Table 2. The decrease in the TSS could be due to the used up of the soluble substrate by the inherent microorganisms. These differences were due to the degree of sweetening and added ginger powder process and the method employed for such purpose. According to Abiodun, (2017) most products with high values of total soluble solids usually have granulated sugar added to taste according to consumer preference The result of this work agree with the literature value (7.67) reported by Akoma *et al.,* (2006) and Amusa and Ashaye, (2009). The total soluble solid results obtained were higher than 7.70-8.75 obtained by Elmahmood and Doughari, (2007). The microorganisms present in the *kunun zaki* samples could have converted the fermentable sugars being utilized for their growth (Okafor, 2001). This finding agrees with the observation of Igue, (1995).

Table 2: Table total soluble solid content (TSSC) of acha-ginger blend kunu zaki

Storage(Days)	Samples (g/ml)				
	A	B	C	D	E
1	10.91±0.01a	10.64±0.01a	10.49±0.01 a	10.61±0.01a	10.49±0.48a
2	10.64±0.01a	10.59±0.01b	10.31±0.01 bc	10.49±0.01b	10.46±0.01a
3	10.29±0.01a	10.46±0.48b	10.44±0.01 b	10.34±0.01c	10.44±0.01ab
4	10.34±0.01a	10.22±0.01c	10.21±0.02 c	10.31±0.01c	10.39±0.01ab
5	10.43±0.01a	10.40±0.01c	9.11±0.01c	10.17±0.01a	10.27±0.21c

*Values are means ± standard deviation of 2 replications. Means with different superscripts within the same column are significantly different from each other at $p<0.05$.
Ratio of acha-ginger: A= 100:0, B= 99:1, C= 98:2, D= 97:3, E=96:4.

The result of pH values of the added ginger powder on *kunun zaki* drinks were presented in Table 3. The pH o the acha-ginger blend kunu zaki increased from 3.12 - 3.64 with increase in the added ginger powder (0 – 4%), respectively and subsequently decreased from 3.12 – 2.11, 3.66 - 2.35, 3.57 – 2.40, 3.58 – 2.11 and 3.64 – 2.49% with increase in the storage duration (1-5days). The changes in the pH could be due to the breakdown of the compounds in the added ginger and the acha flour which increased with the increase in the duration of storage.

Table 3: pH of *acha-ginger blend kunun zaki*

Storage (days)	Samples				
	A	B	C	D	E
1	3.12±0.02^{e}	3.36±0.01^{e}	3.57±0.01^{e}	3.58±0.01^{e}	3.64±0.01^{d}
2	2.94±0.01^{d}	3.07±0.01^{d}	3.28±0.01^{d}	3.44±0.05^{d}	3.49±0.01^{c}
3	2.87±0.00c	2.94±0.01^{c}	3.22±0.01^{c}	3.35±0.01^{c}	3.45±0.01^{b}
4	2.32±0.00^{b}	2.61±0.01^{b}	2.73±0.01^{b}	2.43±0.01^{b}	2.46±0.01^{a}
5	2.11±0.01^{a}	2.35±0.01^{a}	2.40±0.01^{a}	2.11±0.01^{a}	2.49±0.02^{a}

*Values are means ± standard deviation of 2 replications. Means with different superscripts within the same column are significantly different from each other at $p<0.05$.
Ratio of acha-ginger: A=100:0, B= 99:1, C= 98:2, D= 97:3, E= 96:4.

The result of titratable acidity (TTA) values of the ginger powder addition drinks are presented in Table 4. The total titratable acidity (TTA) of the acha-ginger blend kunun zaki ranged from 0.46 – 0.69 mg/100 ml wit increase in the

added ginger powder (0-4%). However, the TTA subsequently increased from 0.46 – 0.73, 0.45 - 0.48, then decreased from 0.56- 0.43, 0.49 – 37, and 0.69 - 0.39 mg/100 ml with increase in duration of storage (1-5days). The TTA had the same trend with that of the pH.

The pH results obtained were lower than 4.70-5.75 obtained by Gaffa and Ayo (2002), Akoma *et al*., (2006) and Amusa and Ashaye (2009). However, the pH values were similar to the results (3.3-4.3) obtained by Elmahmood and Doughari (2007) but lower than (3.70 to 3.90) as reported by Makinde and Oyeleke (2012) using sesame seed in the production of *kunun zaki*. This agreed with the finding of Ndife *et al.,* (2013) that addition of ginger powder increased the pH (reduced the acidity). The result of this work compare favorably with that reported of Oshoma *et al*. (2009).

Table 4. TTA of ginger of *acha-ginger blend kunun zaki*

Storage (days)	Samples				
Days	A	B	C	D	E
1	0.46 ± 0.01^{a}	0.45 ± 0.01^{c}	0.56 ± 0.01^{c}	0.49 ± 0.01^{b}	0.69 ± 0.01^{e}
2	0.58 ± 0.02^{b}	0.56 ± 0.07^{c}	0.52 ± 0.01^{c}	0.51 ± 0.01^{b}	0.53 ± 0.01^{d}
3	0.63 ± 0.01^{c}	0.46 ± 0.01^{b}	0.47 ± 0.01^{b}	0.52 ± 0.01^{b}	0.47 ± 0.01^{c}
4	0.70 ± 0.01^{d}	0.41 ± 0.01^{a}	0.42 ± 0.01^{a}	0.38 ± 0.01^{a}	0.44 ± 0.01^{b}
5	0.73 ± 0.01^{e}	0.48 ± 0.01^{a}	0.43 ± 0.01^{a}	0.37 ± 0.01^{a}	0.39 ± 0.01^{a}

*Values are means ± standard deviation of 2 replications. Means with different superscripts within the same column are significantly different from each other at $p<0.05$

Ratio of acha-ginger: A= 100:0, B= 99:1, C= 98:2, D= 97:3, E= 96:4

According to Abidoye *et al*. (2016) the acidity of the samples can be attributed to the added species. It can also be traced to the presence of some bacteria like lactobacillus, acidophillus, candida species and Saccharomyces cerevisiae which help in acid fermentation of *kunu zaki*. There was an increase in the TTA value in control sample throughout the storage days and this sample without ginger powder which agreed with Ashiru *et al*. (2003).

The acidity of *kunun zaki* beverage has been noted to be as a result of lactic acid production by some bacteria during fermentation (Ashiru *et al., 2003*) and thus, the drink becomes sour in taste and organoleptically unacceptable with time as observed in the control sample. According to Odunfa and Adeyeye, (1999), the presence of some of these organisms are not surprising as most of them are known to thrive in medium rich in fermentable substrates such as sugars which often led to the production of acids after fermentation. Odunfa and Adeyeye, (1999) reported that *L. plantarum* is the predominant organism in the fermentation responsible for lactic acid productionThe result of this work however shows significant effect of addition of ginger powder on *kunun zaki*. There were significant differences $p>0.05$ in the titratable acidity of the sample 96:4 and the values decreased from (0.47 to 0.39%) throughout the storage (1-5day). This has been noted to be as a result of ginger powder addition reduced the presence of some bacteria help in acid fermentation in *kunun zaki* hence increased the shelf life of the product.

Effect of added ginger powder on microbiological quality of *acha kunun zaki*

The result of total bacterial count of the added ginger powder on *kunun zaki* drinks were presented in Table 5. The total bacterial count of the acha-ginger blend kunun zaki decreased from 2.03 to 1.60cfu/ml with increase in the added ginger powder and subsequently increased from 2.03 -15.65, 1.75 – 6.84, 1.65 – 6.34, 1.60 – 4.56 and 1.60 – 4.25cfu/ml with increase in duration of storage(1-5days). The growth in the control sample was lower than 2.1cfu/mL observed by Mbachu *et al.*, (2014). Ginger has strong antibacterial and to some extent antifungal properties too (Kapoor, 1997; Habsah *et al.,* 2000; Srinivasan *et al.,* 2001). Sample 4% added ginger powder had the least bacterial count throughout the storage. The result of this analysis agreed with many report and attributed to the pence of Gingerol, particularly 6-gingerol, has been found to be the most active compound biologically (Yamahara *et al.,* 2001; Mascolo *et al*., 2002; Lam *et al*., 2007; Wu *et al*., 2010 ; Yang *et al.,* 2010). Ginger has strong antibacterial potential and to some extent antifungal properties (Habsah *et al.,* 2000; Srinivasan *et al.,* 2001). In vitro studies have shown that active constituents of ginger inhibit multiplication of colon bacteria (Bakhru, 1999).

Ginger at a relatively higher concentration could also inhibit the growth of Escherichia coli, Proteus spp., Staphylococci, Streptococci and Salmonella (Gugnani and Ezenwanze, 2000; James *et al.,* 1999). O'Mahony *et al.* (2005) reported curative effects against Helicobacter pylori. Fresh ginger juice showed inhibitory action against Aspergillus niger, Saccharomyces cerevisiae, Mycoderma spp. and Lacto-bacillus acidophilus at 4, 10, 12 and 14%, respectively, at ambient temperatures (Martins *et al.,* 2001). Martins *et al.,* (2001) demonstrated antimicrobial activity of essential oil against gram-positive and gram-negative bacteria using agar diffusion method. Samples decreased at a relative higher rate compared to the control sample and higher than the values observed by Mbachu *et al.,* (2014). As the added ginger powder increased, the fungi count decreased. The decrease in fungi count for the ginger powder addition samples could be attributed to the preservative nature of the ginger powder which was not favorable for rapid multiplication of microbial organisms in *acha kunun zaki* stored in 5 days. The result of this analysis agreed with many report which stated that Gingerol, particularly 6-gingerol, has been found to be the most active compound biologically and has strong antifungal properties (Kapoor, 2000; Habsah *et al.,* 2000; Srinivasan *et al.,* 200 (Yamahara *et al.,* 2001; Mascolo *et al*., 2002; Huang *et al*.,2003; Mustafa *et al.,* 1993; Aeschbach *et al.,* 1994; Agarwal *et al*., 2001; Lam *et al.,* 2007; Wu *et al*., 2010). Biochemical test as shown in Table 8 identify the most predominantly bacteria as *E. coli Kleb.Ent*, which is a pathogens organism. The possible source of this could be the University water which has been confirmed as untreared.

Table 7: Total Fungi of acha-ginger blend kunun zaki

Duration (days)	Samples				
	A	B	C	D	E
1	1.00±0.00[a]	1.75±0.01[a]	1.60±0.14[a]	1.05±0.07[a]	1.05±0.14[a]
2	14.05±0.07[d]	12.95±0.07[d]	14.60±0.14[d]	10.70±0.14[d]	3.30±0.14[d]
3	14.85±0.01[e]	15.50±0.14[e]	17.35±0.07[e]	11.66±1.20[e]	4.55±0.12[e]
4	6.05±0.07[c]	3.95±0.07[b]	6.60±0.14[c]	1.70±0.04[b]	1.60±0.70[c]
5	5.70±0.00[b]	3.70±0.00[c]	2.90±0.14[b]	1.45±0.07[c]	1.10±0.14[b]

*Values are means ± standard deviation of 2 replications. Means with different superscripts within the same column are significantly different from each other at $p<0.05$

Ratio of *acha*-ginger: A= 100:0, B= 99:1, C= 98:2, D= 97:3, E = 96:4

Table 8: Biochemical quality of acah-ginger blend kunun zaki

Ginger (%)	Duration (days)	Organism Suspected	Reaction on Slant	Reaction on Butt	Sugar Fermented	Gas	H2S
0	1	*E.coli,Kleb.Ent.,*	Acid (A)	Acid (A)	Lac./Suc.	Neg (-)	Neg (-)
	2	*E.coli,Kleb.,Ent.*	Acid (A)	Acid (A)	Lac./Suc.	Pos (+)	Neg (-)
	3	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc.	Pos (+)	Neg (-)
	4	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc.	Pos (+)	Neg (-)
	5	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc.	Pos (+)	Neg (-)
1	1	*E.coli,Kleb.,Ent,*	Acid (A)	Acid (A)	Lac./Suc.	Neg (-)	Neg (-)
	2	*E.coli,Kleb.,Ent,*	Acid (A)	Acid (A)	Lac./Suc.	Neg (-)	Neg (-)
	3	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc.	Pos (+)	Neg (-)
	4	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc.	Pos (+)	Neg (-)
	5	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc.	Pos (+)	Neg (-)
2	1	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc.	Neg (-)	Neg (-)
	2	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc.	Neg (-)	Neg (-)
	3	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lactose/	Neg (-)	Neg (-)
	4	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc.	Pos (+)	Neg (-)
	5	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc	Pos (+)	Neg (-)
3	1	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc.	Neg (-)	Neg (-)
	2	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc.	Neg (-)	Neg (-)
	3	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc	Neg (-)	Neg (-)
	4	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc.	Pos (+)	Neg (-)
	5	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc.	Pos (+)	Neg (-)
4	1	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc.	Neg (-)	Neg (-)
	2	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc.	Neg (-)	Neg (-)
	3	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc.	Neg (-)	Neg (-)
	4	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc.	Pos (+)	Neg (-)
	5	*E.coli,Kleb.,Ent*	Acid (A)	Acid (A)	Lac./Suc.	Pos (+)	Neg (-)

*Triple Sugar Iron (TSI) Agar Reactions: Acidic slant/acidic butt (A/A); Yellow/Yellow = glucose, lactose and/or sucrose fermenter gas (+ or -), H2s (+ or -).

Organisms: *E.coli. (Escherichia); Kleb.(Klebsiella); Ent. (Enterobacter).*

Sensory properties of *acha-ginger blend kunun zaki* drink

The sensory properties of *acha* based *kunun zaki* stored under the same condition (room temperature) for five days are shown in Table 9 to 12. The average means cores for the colour of the five samples (0, 1, 2, 3, 4) acha ginger blend kunun zaki decreased from 7.45 to 6.05, 6.20 – 5.15, 5.35 – 4.25, 5.35- 4.25 and 5.15- 4.10, respectively, with increase in the duration (1-5days) of storage.The decrease in the average mean scores for the colour could be due to break down of colour pigments inherent in the acha with increase in the storage duration. The average means cores for the texture of the five samples(0, 1,2,3,4) acha ginger blend kunun zaki decreased from 6.35-5.80,6.15-5.30, 6.02-5.35, 5.20-4.80 and 5.10-4.20, respectively, with increase in the duration (1-5days) of storage. The decrease in the average mean scores of texture could be due to increase in the total solids content as a result of increase in the added ginger powder consequently affecting the after mouth taste of the drink. The average means cores for the taste of the five samples(0, 1,2,3,4) acha ginger blend kunun zaki decreased from 6.00-4.76, 5.80-4.55, 5.55-4.30, 4.90 - 3.85 and 4.42-3.10, respectively, with increase in the duration (1-5days) of storage. The decrease in the average mean scores of the taste could be due to the possible fermentation of the soluble solids including sugar content, consequently reducing the sweetness of the drink and its acceptability. The average means cores for the odour of the five samples(0, 1,2,3,4) acha ginger blend kunun zaki decreased from 6.45-5.00, 6.15- 4.90, 5.55-5.01, 5.45-4.75 and 5.45-4.51, respectively, with increase in the duration (1-5days) of storage. Generally the odour of the acha-ginger is acceptable (6.45-4.45). The decrease in the average mean scores of the odour could be due to the harsh odour attributed to high concentration of the ginger at high level. The average means cores for the general acceptability of the five samples(0, 1,2,3,4) acha ginger blend kunun zaki decreased from6.75-4.81, 5.51-4.50, 5.40-4.36, 5.05-3.70 and 4.30-3.15, respectively, with increase in the duration (1-5days) of storage. The relative low average means scores (3.15 -4.35) of acha-ginger blend kunnun zaki at higher ginger concentration (3-4%) and storage duration above days could be attributed to production of by products from fermentation and ginger components. Moreover as the

days of storage duration increased, the sensory attributes of the samples decreased but those of the ginger powder addition samples decreased at a higher rate compared to the control sample and lower than the values observed by Odunfa and Adeyeye, (1999).

Table 9: Color of *acha-ginger blend kunun zaki*

Ginger powder (%)	Storage duration (days)				
	1	2	3	4	5
0	7.45±1.27^{a}	6.95±1.43^{a}	6.52±0.60^{a}	6.40±1.81^{a}	6.05±0.23^{a}
1	6.20±3.51^{a}	5.85±1.66^{ab}	5.65±2.34^{b}	5.40±2.00^{b}	5.15±1.63^{b}
2	5.35±2.32^{a}	5.05±1.82^{b}	4.95±1.63^{b}	4.46±2.30^{c}	4.25±2.29^{c}
3	5.35±2.45^{a}	4.85±2.23^{b}	4.40±1.98^{b}	4.30±0.20^{c}	4.25±2.41^{c}
4	5.15±1.56^{a}	4.94±1.61^{b}	4.30±2.00^{b}	4.30±1.55^{c}	4.10±0.51^{c}

*Values are Average means scores; ± standard deviation of 15 panelist.
Average means scores with different superscripts within the same column are significantly different from each other at $p<0.05$.

Table 10: Texture of acha- ginger blend kunun zaki

Ginger powder %	Storage Duration (days)				
	1	2	3	4	5
0	6.35±1.53^{a}	6.10±1.37^{a}	6.10±1.68^{a}	6.10±0.21^{a}	5.80±1.60^{a}
1	6.15±2.60a	6.10±1.55^{ab}	6.00±0.30^{ab}	5.90±1.61^{ab}	5.30±1.92^{b}
2	6.02±0.21^{a}	5.70±1.26^{ab}	5.40±0.88^{abc}	5.35±1.30^{bc}	5.35±1.05^{bc}
3	5.20±0.11^{a}	5.16±1.46^{ab}	5.00±1.58^{b}	4.85±1.78^{c}	4.80±2.62^{c}
4	5.10±1.32^{a}	5.05±1.73^{b}	4.80±0.32^{bc}	4.30±1.08^{c}	4.20±1.79^{c}

*Values are average means scores; ± standard deviation of 15 panelist.
Average means scores with different superscripts within the same column are significantly different from each other at $p<0.05$.

Table 11: Taste of *acha-ginger blend kunun zaki*

Ginger powder (%)	Storage duration (days)				
	1	2	3	4	5
0	6.00±1.52^{a}	5.90±0.75^{a}	5.55±1.57^{a}	5.20±0.21^{a}	4.76±1.80^{a}
1	5.80±1.70^{ab}	5.60±1.46^{ab}	5.11±0.41^{ab}	4.80±1.79 ^{b}	4.55±1.70^{b}
2	5.55±1.66^{ab}	5.10±2.43^{ab}	4.60±1.69^{ab}	4.50±0.32^{b}	4.30±1.75^{b}
3	4.90±1.11^{a}	4.80±2.04^{ab}	4.50±0.21^{b}	3.90±1.77^{bc}	3.85±0.81^{c}
4	4.42±0.50^{a}	4.20±1.98^{b}	4.15±1.75^{c}	3.90±2.99^{c}	3.10±2.02^{c}

*Values are average mean scores; ± standard deviation of 15 panelist.
Average mean scores with different superscripts within the same column are significantly different from each other at $p<0.05$.

Table 12: Odor of *acha –ginger blend kunun zaki*

Ginger powder (%)	Storage duration (days)				
	1	2	3	4	5
0	6.45±1.57^{a}	6.00±2.27^{a}	5.80±1.93^{a}	5.30±2.29^{a}	5.00±0.41^{a}
1	6.15±1.75^{a}	5.85±1.73^{a}	5.55±1.85^{a}	4.90±2.31^{a}	4.90±2.30^{a}
2	5.55±1.70^{a}	5.50±1.60^{a}	5.20±2.23^{a}	5.20±2.54^{a}	5.01±1.20^{a}
3	5.45±1.93^{a}	5.40±2.25^{a}	5.40±1.76^{a}	4.82±2.10^{b}	4.75±2.02^{a}
4	5.45±1.70^{a}	5.00±1.94^{a}	5.10±1.86^{a}	4.95±2.30^{a}	4.51±0.81^{a}

*Values are average mean scores; ± standard deviation of 15 panelist.
Average means scores with different superscripts within the same column are significantly different from each other at $p<0.05$.

Table 13: General acceptability of *acha-ginger blend kunun zaki*

Ginger powder (%)	Storage duration (days)				
	1	2	3	4	5
0	6.75±1.88^{a}	6.35±2.45^{a}	6.05±2.05^{a}	5.75±1.99^{a}	4.81±0.50^{a}
1	5.51±0.10^{a}	5.25±1.80^{ab}	5.20±1.93^{b}	4.71±0.80^{b}	4.50±1.63^{b}
2	5.40±2.34^{ab}	4.75±1.58^{b}	4.51±0.20^{bc}	4.45±1.93^{bc}	4.36±1.87^{bc}
3	5.05±1.82^{a}	4.80±2.04^{b}	4.35±2.49^{b}	4.30±3.02^{bc}	3.70±1.70^{bc}
4	4.30±0.31^{a}	4.10±2.14^{b}	3.90±2.02^{b}	3.65±2.79^{c}	3.15±2.05^{s}

*Values are average mean scores; ± standard deviation of 15 panelist.
Average Means scores with different superscripts within the same column are significantly different from each other at $p<0.05$.

CONCLUSION

The addition of ginger powder to acha base kunun at a very low concentration (less than 3%) have relatively improve the sensory quality particularly the taste and odour and to a very little extent extended the shelf life of the product to about three days.

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