

ACCEPTABILITY AND PHYSICOCHEMICAL ATTRIBUTES OF YOGHURT FORTIFIED WITH GINGER AND GARLIC

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Abstract

Yoghurt is a product from the lactic acid fermentation of milk through the action of bacterial cultures. In this work, yoghurt was produced from raw cow milk and fortified with ginger and garlic in varied proportions (0.2 – 0.8%). The acceptability and physicochemical qualities of the yoghurt samples were evaluated using standard methods. The results obtained showed that the samples differed significantly ($p < 0.05$) in overall acceptability but not in colour and consistency. There were also significant differences in proximate compositions: protein (4.28 – 4.85%) and carbohydrate (10.68 – 11.94%) contents increased with increased levels of ginger and garlic while a decreasing trend was recorded in moisture content (80.37 – 79.95%) as well as in fat (3.29 – 2.57%). The ash content (0.68 – 0.72%) increased with increased ginger inclusion. There were increases in calcium, magnesium, phosphorus, iron and potassium contents of the yoghurt samples as garlic and ginger inclusion levels increased. The pH and total titratable acidity values were 4.3 – 4.9 and 0.22 – 0.26 g/100 ml, respectively. The study has therefore revealed that ginger and garlic inclusion in yoghurt production is feasible and has a positive effect on the nutritional qualities and overall acceptability of the product.

Keywords: Physicochemical, Acceptability, Yoghurt, Garlic, Ginger

INTRODUCTION

Yoghurt is a product from lactic acid fermentation of pasteurized milk. It involves the addition of starter culture or yoghurt cultures to milk (Willey *et al.*, 2008). Some of the bacteria are *Streptococcus thermophilus* and *Lactobacillus bulgaricus* which are mostly obtained commercially in sachets (Falade *et al.*, 2014). Other *Lactobacilli* and *Bifidobacteriacan* also be added during or after culturing yoghurt (Adolfsson *et al.*, 2004). Fermentation of milk occurs when the above-mentioned bacteria act on the milk sugar (lactose) converting it to lactic acid which in turn results in the curdling of the milk protein (casein). These chemical changes are responsible for the characteristic flavor and viscosity of yoghurt. Yoghurt is one of the popular fermented milk products known for thousands of years, and has taken much attention in few years with the advent of probiotics in dairy products. Being nutritionally rich in protein, calcium, potassium, riboflavin, vitamin B₆ and vitamin B₁₂, yoghurt is considered to have more nutritional benefits than milk and suitable for the growth of children. It has a long history of medicinal uses, particularly for

diarrhea and a variety of gastrointestinal diseases (Muniandy *et al.*, 2016).

Ginger (*Zingiber officinale*) is a creeping perennial on a thick, tuberous rhizome, which spreads under the ground. In the first year, a green erect reed-like stem, about 60 cm high, grows from this rhizome. The plant has narrow lanceolate to linear-lanceolate, 15-30 cm long leaves which die off each year. The characteristic smell and taste of ginger is aromatic and pungent (Samir and Anrit, 2003). As a spice, it has been used for medicinal, pharmaceutical and cooking purposes. It is used for treating nausea, vomiting, and morning sickness; as a pain reliever (in arthritis), anti-inflammatory agent, as well as in the curing of ulcer and prevention of heart attack and stroke (The Herb Society of America Fact Sheet, 2006).

Garlic, also like ginger, has a long history of medicinal use for a wide variety of conditions, and was once known as 'poor-man's treacle' (or cure-all). In folk medicine, garlic has been used to treat bronchitis and respiratory problems, gastrointestinal problems, flatulence, leprosy, menstrual cramps, high blood pressure and diabetes. It has also

been used externally for warts, corns, arthritis, muscle pain, neuralgia and sciatica. Recently, science has begun to confirm some of garlic's long-standing medicinal uses. It has been shown to lower blood cholesterol, blood pressure and blood sugar in studies and clinical trials and has also demonstrated anti-cancer, antibacterial, anti-fungal and anti-oxidant effects (The Herb Society of America Fact Sheet, 2006). This work was aimed at improving the nutritional quality of yoghurt through the inclusion of garlic and ginger by harnessing the medicinal benefits inherent in the two spices.

MATERIALS AND METHODS

The fresh cow milk, starter culture, flavour, sugar, ginger and garlic used were all obtained from a local market in Ilorin, Kwara State.

Production of yoghurt

The method described by Falade *et al.*, (2014) for yoghurt production was used with slight modification. Raw milk was pasteurized at 85°C for 30 mins. The pasteurized milk was cooled to around 40-45°C, after which it was inoculated with commercial starter culture containing a mixed strain of *Streptococcus thermophilus* and

Lactobacillus bulgaricus (0.5g of the culture was used to inoculate 1000ml of milk to initiate fermentation). The milk was incubated in a tight-fitted container at room temperature (27 ± 2°C) for 10 hours, during which the characteristic yoghurt flavor developed. Sugar was added to taste as well as powdered milk flavor. The yoghurt was then filled into sterile plastic bottles, corked and stored in a refrigerator for subsequent analyses. The pH, titratable acidity, microbial stability, and sensory qualities of the yoghurt samples were then monitored, as well as their proximate compositions.

Production of ginger and garlic juices

The method described by Ahammed *et al.* (2014) was adopted. Raw tubers of ginger were peeled, washed and blended using a blending machine, then sieved to remove fibrous materials. The garlic juice was prepared the same way.

Production of ginger-garlic yoghurt

The ginger and garlic juices were added to the yoghurt in different proportions as outlined in Table 1. A total of twelve (12) samples and

a control were used for the analyses.

Chemical analysis of yoghurt samples

Proximate composition: The proximate compositions comprising moisture, ash, fat, and crude protein of the various yoghurt samples were determined using standard methods of AOAC (2000). Carbohydrate determination was by difference.

Mineral composition: Aqua-regia method (AOAC, 2000) was used to determine the mineral composition of the yoghurt samples.

pH and Total Titratable Acidity (TTA): AOAC (2000) method was used to determine the pH of the various yoghurt samples while the Total Titratable Acidity was determined using the method described by Agarry *et al.* (2010).

Sensory Evaluation

The sensory qualities of the yoghurt samples were evaluated using a multiple paired comparison test. The sensory parameters evaluated were colour, taste, aroma, consistency and overall acceptability. A panel comprising 20 semi-trained panelists tested the samples using a 9-point hedonic type scale of

preference, with 1 representing the least score (dislike extremely) and 9, the highest (like extremely).

Statistical Analysis

The results obtained were subjected to analysis of variance (ANOVA) using statistical package for social sciences (SPSS) Version 16.0. Means were separated using Duncan test.

Results and discussion

The proximate compositions of the various ginger and garlic fortified yoghurt samples showed significant differences. This significant difference can be attributed to the different variations of ginger and garlic that were added to the yoghurt. The moisture contents ranged between 80.9 and 79.95% with the control (100% yoghurt) having the highest value and sample YGG₄ (99% yoghurt, 0.8% ginger, 0.2% garlic) having the lowest. The reduction in moisture content can be attributed to the incorporation of garlic and ginger juice and means better shelf stability for the product. Ihenjir *et al.*, (2015) recommended that the moisture content of yoghurt should be around 84%. The trends observed in protein content of yoghurt showed increment with increasing percentages of ginger and garlic.

There was a significant difference in protein content among the various yoghurt samples. The protein content increased as the level of ginger and garlic incorporation increased. This observed trend agrees with the findings of Ahammed *et al* (2014) and Odegunmi *et al* (2009) who reported garlic and ginger have a considerable amount of protein and thus might help increase the protein content of yoghurt. On the contrary, the trend observed in the fat content of the yoghurt was found to be different from that of protein, the control sample had the highest (3.30%) fat content. Yoghurt samples with ginger, garlic and the mixture of both declined in fat contents from 3.20 – 2.57%. This variation may be associated with the varying proportions of ginger and garlic used. Ginger and garlic are quite low in fat (Odegunmi *et al*, 2009). Akande *et al* (2009) recorded a lower range of fat content when compared with fat content in cow milk. Significantly, fat is important as a source of energy in human body (Onyeka, 2008). The ash content of yoghurt varied significantly ($p < 0.05$) and increased among the yoghurt samples with increased addition of ginger, but reverse was the case

with increased level of garlic inclusion. This can be attributed to a higher ash content of ginger than garlic as reported by Odegunmi *et al* (2009). Ash content in foodstuffs is a measure of mineral elements present in the foodstuffs. The carbohydrate content increased with increased levels of ginger and garlic. This is attributable to the abundance of carbohydrate in garlic and ginger. There was a progressive increase in the mineral contents of the yoghurt samples as the level of ginger and garlic inclusion increased. This increase can be due to the high mineral contents of ginger and garlic. Calcium content ranged between 116.336 and 125.083 mg/100g. Magnesium contents of the yoghurt were relatively low (10.429 – 11.377 mg/100g). The yoghurt samples were also very high in potassium. These ranged between 146.845 and 148.841 mg/100g. Other minerals present were iron (0.041 – 0.069 mg/100g) and phosphorus (89.633 – 94.961 mg/100g). Mineral elements are inorganic matters that play important roles in human nutrition and their inadequacy may result to nutritional disorder (Onyeka, 2008). Calcium helps in regulation of muscle contractions,

transmit nerve impulses and help in bone formation (Balogun and Oyeyiola, 2012). Potassium is an essential nutrient and has an important role in the synthesis of amino acids and proteins (Balogun and Oyeyiola, 2012). Phosphorus is needed for bone growth, kidney function and cell growth; it also plays a major role in maintaining the body's acid-alkaline balance (Fallon, 2001). Magnesium helps the formation of strong bones and teeth while deficiency of magnesium in man is responsible for severe diarrhea, hypertension and stroke. Iron is an important element in the diet of pregnant women, patients and elderly to prevent anaemia and other related diseases (Oluwemi *et al*, 2006). The pH values ranged between 4.3 and 4.9. These values fall within the range reported by Tamime *et al*, (2005). The results of the sensory evaluation showed that the garlic-ginger yoghurt samples compared favourably with the control (100% yoghurt) in the sensory attributes tested, except in taste and aroma which were scored low by the panelists. There was no significant difference in colour and consistency. Samples GIY₂ and YGG₂ were most preferred in

overall acceptability. This means the ginger-garlic yoghurt will be acceptable by consumers. This can be partly attributed to the fact that the colour of the yoghurt samples was not impaired by the addition of ginger and garlic. Colour is described as one of the significant factors that affect acceptability of food products (Lee and Lucey, 2000).

Conclusions

The addition of ginger and garlic improved the nutritional value of yoghurt. Though the taste and aroma were a little impaired, samples GIY₂ (99.6% yoghurt, 0.4% ginger) and YGG₂ (99% yoghurt, 0.4% ginger, 0.6% garlic) had the highest overall preference. Therefore, it can be concluded that the production of ginger-garlic yoghurt is feasible, and also, with a moderate level of ginger and garlic inclusion, would be well accepted by prospective consumers.

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Balogun, M.A., Kolawole, F.L., Akintayo, O.A. ACCEPTABILITY AND PHYSICOCHEMICAL ATTRIBUTES OF YOGHURT FORTIFIED WITH GINGER AND GARLIC

SAMPLES	Yoghurt (%)	Starter Culture(g)	Sugar (g)	Flavour (g)	Ginger (%)	Garlic (%)
CONTROL	100	20	70	10	-	-

Table 1: Formulation of Ginger-garlic yoghurt

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GIY ₁	99.8	20	70	10	0.2	-	KEYS
GIY ₂	99.6	20	70	10	0.4	-	CONTR
GIY ₃	99.4	20	70	10	0.6	-	OL:
GIY ₄	99.2	20	70	10	0.8	-	100%
GAY ₁	99.8	20	70	10	-	0.2	yoghurt,
GAY ₂	99.6	20	70	10	-	0.4	GIY ₁ :
GAY ₃	99.4	20	70	10	-	0.6	99.8%
GAY ₄	99.2	20	70	10	-	0.8	yoghurt,
YGG ₁	99.0	20	70	10	0.2	0.8	0.2%
YGG ₂	99.0	20	70	10	0.4	0.6	yoghurt,
YGG ₃	99.0	20	70	10	0.6	0.4	0.4%
YGG ₄	99.0	20	70	10	0.8	0.2	ginger,

99.8% yoghurt, 0.2% garlic, GAY₂: 99.6% yoghurt, 0.4% garlic, GAY₃: 99.4% yoghurt, 0.6% garlic, GAY₄: 99.2% yoghurt, 0.8% garlic, YGG₁: 99% yoghurt, 0.2% ginger, 0.8% garlic, YGG₂: 99% yoghurt, 0.4% ginger, 0.6% garlic, YGG₃: 99% yoghurt, 0.6% ginger, 0.4% garlic, YGG₄: 99% yoghurt, 0.8% ginger, 0.2% garlic.

Table 2: Proximate Composition of Yoghurt Samples

Samples	Calcium (mg/10)	Magnesium (mg/100g)	Potassium (mg/100g)	Iron (mg/10)	Phosphorous (mg/100g)
CONTROL	116.336	10.429	146.845	0.041	89.633
GIY ₁	116.403	10.457	146.845	0.041	89.642
GIY ₂	116.432	10.468	146.849	0.044	89.674
GIY ₃	116.483	10.516	146.859	0.046	89.746
GIY ₄	116.982	10.565	146.872	0.049	89.932
GAY ₁	117.562	10.635	146.954	0.052	90.019
GAY ₂	118.473	10.663	147.457	0.056	90.424
GAY ₃	118.489	10.677	147.559	0.058	90.595
GAY ₄	118.537	10.765	147.683	0.058	90.789
YGG ₁	119.166	10.857	147.845	0.062	91.564
YGG ₂	120.736	10.964	147.849	0.064	91.643
YGG ₃	121.137	11.085	147.913	0.068	92.765
YGG ₄	125.083	11.377	148.841	0.069	94.961

In each of the columns, any means not followed by the same superscripts are significantly different ($p < 0.05$).

KEYS

CONTROL: 100% yoghurt, GIY₁: 99.8% yoghurt, 0.2% ginger, GIY₂: 99.6% yoghurt, 0.4% ginger, GIY₃: 99.4% yoghurt, 0.6% ginger, GIY₄: 99.2% yoghurt, 0.8% ginger, GAY₁: 99.8% yoghurt, 0.2% garlic, GAY₂: 99.6% yoghurt, 0.4% garlic, GAY₃: 99.4% yoghurt, 0.6% garlic, GAY₄: 99.2% yoghurt, 0.8% garlic, YGG₁: 99% yoghurt, 0.2% ginger, 0.8% garlic, YGG₂: 99% yoghurt, 0.4% ginger, 0.6% garlic, YGG₃: 99% yoghurt, 0.6% ginger, 0.4% garlic, YGG₄: 99% yoghurt, 0.8% ginger, 0.2% garlic.

Table 4: pH and Total Titratable Acidity of Yoghurt Samples

Samples	TTA (g/100 ml)	pH
CONTROL	0.23	4.5
GIY ₁	0.24	4.6
GIY ₂	0.23	4.6
GIY ₃	0.24	4.7
GIY ₄	0.22	4.7
GAY ₁	0.24	4.7
GAY ₂	0.23	4.8
GAY ₃	0.24	4.7
GAY ₄	0.23	4.8
YGG ₁	0.22	4.7
YGG ₂	0.24	4.7
YGG ₃	0.24	4.8
YGG ₄	0.23	4.9

In each of the columns, any means not followed by the same superscripts are significantly different ($p < 0.05$).

KEYS

CONTROL: 100% yoghurt, GIY₁: 99.8% yoghurt, 0.2% ginger, GIY₂: 99.6% yoghurt, 0.4% ginger, GIY₃: 99.4% yoghurt, 0.6% ginger, GIY₄: 99.2% yoghurt, 0.8% ginger, GAY₁: 99.8% yoghurt, 0.2% garlic, GAY₂: 99.6% yoghurt, 0.4% garlic, GAY₃: 99.4% yoghurt, 0.6% garlic, GAY₄: 99.2% yoghurt, 0.8% garlic, YGG₁: 99% yoghurt, 0.2% ginger, 0.8% garlic, YGG₂: 99% yoghurt, 0.4% ginger, 0.6% garlic, YGG₃: 99% yoghurt, 0.6% ginger, 0.4% garlic, YGG₄: 99% yoghurt, 0.8% ginger, 0.2% garlic.

Samples	TTA (g/100 ml)	pH
CONTROL	0.23	4.5 ^a
GIY ₁	0.24	4.6
GIY ₂	0.23	4.6
GIY ₃	0.24	4.7
GIY ₄	0.22	4.7
GAY ₁	0.24	4.7
GAY ₂	0.23	4.8
GAY ₃	0.24	4.7
GAY ₄	0.23	4.8
YGG ₁	0.22	4.7
YGG ₂	0.24	4.7
YGG ₃	0.24	4.8
YGG ₄	0.23	4.9

In each of the columns, any means not followed by the same superscripts are significantly different (p<0.05).

KEYS

CONTROL: 100% yoghurt, GIY₁: 99.8% yoghurt, 0.2% ginger, GIY₂: 99.6% yoghurt, 0.4% ginger, GIY₃: 99.4% yoghurt, 0.6% ginger, GIY₄: 99.2% yoghurt, 0.8% ginger, GAY₁: 99.8% yoghurt, 0.2% garlic, GAY₂: 99.6% yoghurt, 0.4% garlic, GAY₃: 99.4% yoghurt, 0.6% garlic, GAY₄: 99.2% yoghurt, 0.8% garlic, YGG₁: 99% yoghurt, 0.2% ginger, 0.8% garlic, YGG₂: 99% yoghurt, 0.4% ginger, 0.6% garlic, YGG₃: 99% yoghurt, 0.6% ginger, 0.4% garlic, YGG₄: 99% yoghurt, 0.8% ginger, 0.2% garlic.

Table 5: Sensory Evaluation of Ginger-Garlic Yoghurt

Samples	Colour	Taste	Aroma	Consistency	Overall acceptability
CONTROL	7.60±0.37 ^a	7.00±0.54 ^{ab}	6.00±0.67 ^{abc}	5.90±0.46 ^a	6.60±0.69 ^{ab}
GIY ₁	7.30±0.34 ^a	6.60±0.49 ^{abc}	5.90±0.55 ^{abcd}	6.10±0.43 ^a	6.50±0.54 ^{ab}
GIY ₂	7.50±0.40 ^a	7.40±0.49 ^a	7.00±0.52 ^a	5.90±0.41 ^a	7.20±0.47 ^a
GIY ₃	7.70±0.30 ^a	6.50±0.58 ^{abcd}	5.70±0.59 ^{abcd}	6.20±0.65 ^a	6.40±0.37 ^{ab}
GIY ₄	7.60±0.34 ^a	6.90±0.62 ^{ab}	6.40±0.70 ^{ab}	6.30±0.39 ^a	6.40±0.67 ^{ab}
GAY ₁	7.20±0.59 ^a	4.90±0.77 ^{bcd}	4.50±0.64 ^{bcd}	5.50±0.31 ^a	5.10±0.61 ^{bc}
GAY ₂	7.20±0.29 ^a	4.20±0.73 ^e	3.80±0.76 ^d	5.40±0.37 ^a	5.10±0.61 ^{bc}
GAY ₃	7.10±0.31 ^a	4.50±0.96 ^{cde}	4.00±0.73 ^{cd}	4.90±0.53 ^a	4.70±0.68 ^{bc}
GAY ₄	7.00±0.39 ^a	4.40±0.76 ^{de}	4.30±0.67 ^{bcd}	5.50±0.60 ^a	4.40±0.54 ^c
YGG ₁	7.30±0.45 ^a	4.40±0.77 ^{de}	4.10±0.71 ^{cd}	5.20±0.49 ^a	5.00±0.59 ^{bc}
YGG ₂	7.70±0.37 ^a	7.30±0.59 ^e	6.50±0.72 ^{ab}	6.20±0.42 ^a	7.20±0.51 ^a
YGG ₃	7.10±0.51 ^a	4.20±0.71 ^e	4.50±0.69 ^{bcd}	5.60±0.72 ^a	4.90±0.58 ^{bc}
YGG ₄	7.10±0.37 ^a	4.90±0.64 ^{bcd}	4.90±0.50 ^{bcd}	5.50±0.31 ^a	5.00±0.62 ^{bc}