QUALITY AND SENSORY EVALUATION OF GINGER (*ZINGIBER OFFICINALIS*) FLAVOURED YOGHURT MADE FROM RAW COW MILK

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ABSTRACT

This study was carried out to evaluate the effect of ginger on the physicochemical, microbiological and sensory properties of yoghurt. Seven yoghurt treatments were prepared by incorporating ginger juice and powder at different levels: 0% (T_1 Control), 0.5% ginger juice (T_2), 1.0% ginger juice (T_3), 1.5% ginger juice (T_4), 0.5% ginger powder (T_5), 1.0% ginger powder (T_6) and 1.5% ginger powder (T_7). All the yoghurt samples were analyzed for their physicochemical characteristics (fat, protein, ash, pH, viscosity and total soluble solids), microbial properties and sensory properties (appearance, mouthfeel, flavour, taste and overall acceptability). Total plate count was performed to assess the safety of the products. The results revealed that ginger juice and powder did not affect the protein content, pH and total soluble solids (TSS) of yoghurt but decreased the fat content and viscosity of yoghurt with increased concentrations. The ash content however increased linearly with increase in concentrations of both ginger juice and powder. Addition of ginger extracts decreased the Total Viable Count numerically but the observed differences were not significant ($P>0.05$). Whereas some of the treatments (T_2, T_5 and T_6) had bacterial loads that were within acceptable limits, others (T_1, T_3, T_4 and T_7) presented higher plate count values than the standard (10^7 CFU). Addition of ginger juice and powder at levels higher than 0.5% led to reduction in the acceptability of yoghurt by panelists suggesting that spicing yoghurt with 0.5% ginger extract (juice) during preparation could be recommended for human consumption.

Keywords: *yoghurt, ginger juice, ginger powder, physicochemical, microbiological, sensory properties*

INTRODUCTION

Yoghurt is one of the most widely known and available dairy products. It is the most popular fermented dairy product all over the world (Tamime and Deeth, 1980; Madhu *et al.*, 2012). According to Moreno *et al*. (2013), yoghurt is a very ancient food that has been known by many different names: katyk (Armenia), dahi (India) and zabadi (Egypt). In Ghana, yoghurt is one of the commonly consumed dairy products besides ice cream, local cheese (wagashi) and butter (Aidoo *et al.*, 2009).

Milk is the major ingredient in the production of yoghurt which is produced by bacterial fermentation using a yoghurt starter culture which comprises *Streptococcus thermophiles* and *Lactobacillus bulgaricus*. The culture ferments lactose in milk, and produces lactic acid which gives yoghurt its peculiar flavor and taste. According to Saint *et al.* (2008), the lactic acid produced also helps to maintain the quality of yoghurt during storage. Although milk from various animals has

been used for yoghurt production in various parts of the world, industrialized yoghurt production uses mostly cow milk (Obi *et al.*, 2016). While it is a popular choice for many, some people do not drink milk due to dietary restrictions, allergies or intolerances and or economic reasons. Yoghurt has nutritional benefits beyond those of milk, and people who are moderately lactose intolerant can enjoy it without ill-effects due to the fact that the lactose in the milk is converted to lactic acid by bacteria culture (Kolars, 1984; Ghanson, 2008).

Routray and Mishra (2011) reported that the popularity of yoghurt as a food component has been linked to its sensory characteristics. Yoghurt contains sugar, water and flavoring materials to offset its natural sourness. In order to improve yoghurt quality, different flavoring ingredients are added during manufacturing. Artificial flavours are the most widely used. However, the use of natural flavors, according to Amadou *et al.* (2018) could be more beneficial to the consumer. The use of spices such as ginger (*Zingiber officinalis*) as flavor agent during yoghurt manufacture could be useful considering the fact that, they are plants rich in bioactive components like gingerols, shogaols and curcumin (Yeh *et al.,* 2014), and give some health benefits. Ginger also constitutes a potential source of minerals and vitamins, and has antimicrobial properties which could positively affect the shelf life of yoghurt.

Ginger-flavoured yoghurt is not popular on the Ghanaian market because limited work has been done on it. This study therefore aimed at evaluating the effects of different concentrations (0.5, 1.0 and 1.5%) of ginger juice and powder on the physicochemical, nutritional, microbial and sensory quality of yoghurt prepared from raw cow milk.

MATERIALS AND METHODS

Location of experiment

The experiment was conducted at the Dairy Laboratory of the Dairy/Beef Cattle Research Station, Kwame Nkrumah University of Science and Technology (KNUST) Kumasi, Ghana. The microbial analysis of the yoghurt samples was carried out at the Microbiology Laboratory of the Department of Animal Science, KNUST, while the physicochemical analysis was conducted at the Food Science Laboratory of the College of Science, KNUST.

Sample Collection and Preparation

Fresh cow milk obtained from cattle farmers at Amoam-Achiase in the Ejisu Municipality of the Ashanti Region of Ghana was used for the yoghurt production. The milk was procured right after extraction in the morning. Commercially available yoghurt starter culture, granulated sugar, ginger and ginger powder were obtained from shops in Kumasi.

Preparation of ginger juice

The ginger was washed with clean water and the skin peeled off with the help of a knife. The ginger rhizomes were then rewashed and chopped into small sizes for blending and the juice was extracted by a juicer and filtered with a clean cheese cloth. The filtrate was stored in plastic containers in a refrigerator at 2º C.

Experimental Design

There were seven (7) treatments which contained varying levels of ginger juice and powder as follows: T1=0% ginger (which served as the control), T2=0.5% (6.0ml) ginger juice, T3= 1.0% (12.0ml) ginger juice, T4=1.5% (18.0ml) ginger juice, T5=0.5% (6.0g) ginger powder, T6=1.0% (12.0g) ginger powder and T7=1.5% (18.0g) ginger powder. The treatments had four replicates each resulting in 28 experimental units in a Completely Randomized Design (CRD).

Preparation of ginger flavored yoghurt

The yoghurt was prepared according to the method of Lee and Lucey (2010). Fresh milk was pasteurized by heating at 85ºC-90ºC for five minutes in a water bath and cooled rapidly to inoculation temperature (42ºC-45ºC). This was followed by the addition of 3% starter culture comprising *Streptococcus thermophiles* and *Lactobacillus bulgaricus.* Thereafter, sugar was added to taste and left to incubate at 42ºC-45ºC for three hours. The set yoghurt was then cooled in a refrigerator before manual stirring. After stirring, the yoghurt was divided into four equal proportions. Seven (7) yoghurt samples were prepared from each portion according to the concentrations of the ginger juice and powder

specified in the various treatments. The samples were then kept in the refrigerator for proximate, physicochemical, microbial and sensory evaluation.

Determination of Total Viable Count

The samples were examined for total viable microbial cell counts according to the procedure described by International Organisation for Standardisation (ISO, 2007). An amount of 1ml of the yoghurt sample was pipetted into 9ml sterile solution after the yoghurt sample was shaken for a uniform mixture to be obtained. Tenfold of serial dilutions of sample were made. An amount of 0.1ml from each dilution was plated in duplicate using spread plate method and a glass spreader which was dipped into 70% alcohol, flamed and allowed to cool. It was then applied on the inoculated agar to spread the inoculum over the entire surface of the agar and the inoculum was allowed to dry. The plate was inverted and incubated at 37°C for 24 hours. Plates with 25-250 colonies were selected and counted using colony counter. Total viable count was determined as the average number of colonies divided by dilution factor of the colonies counted multiplied by amount plated.

Physicochemical analysis of yoghurt samples

The yoghurt samples were analysed for ash, fat, protein, total solids (AOAC, 2000) viscosity and pH. A digital calibrated pH meter paper was immersed into 50ml of yoghurt sample for the determination of pH. The values displayed were noted and recorded.

Sensory evaluation of the spiced yoghurt samples

Sensory evaluation of the seven samples was conducted using 30 regular yoghurt consumer panelists. Samples were evaluated based on appearance, mouthfeel, flavor, and overall acceptability. The descriptive scale used for the various categories of the sensory profile analysis is shown in Table 1.

Data Analysis

Statistical analysis was performed on the data obtained using the Minitab General Linear Model, and the sensory parameters were subjected to one-way analysis of variance (ANOVA) and the means were compared using the Tukey's test ($P < 0.05$).

RESULTS AND DISCUSSION

Effects of ginger extracts on chemical composition and physical properties of yoghurt

Results of the chemical composition and physical properties of the yoghurt samples are shown in Table 2. There were significant differences ($P<0.05$) in fat content across the various treatments, which ranged from 1.525 %($T_{2)}$ to 4.103 %($T_{5).}$ The fat content of the control was significantly lower ($P<0.05$) than those of the other treatments except T_2. The highest fat content was observed for T_5 (0.5% ginger powder) but declined when the ginger powder was increased to 1.5%. This reduction in fat content could be attributed to the low level of fat in the ginger powder which was consistent with findings of Njoya *et al.,* (2016); De Silva and Rathnayaka, (2014); Yousef *et al.,* (2013) and Salwa *et al.,* (2004).

Table 1: Descriptive scale for sensory analysis

Sensory Profile	Scale Description				
	1	2	3	4	5
Appearance	Very plain	Moderately plain	Neither plain nor brown	Moderately brown	Very brown
Mouthfeel	Very smooth	Moderately smooth	Neither smooth nor rough	Moderately rough	Very rough
Flavour	Very mild	Moderately mild	Neither mild nor strong	Moderately strong	Very strong
Taste	Very good	Moderately good	Neither good or bad	Moderately bad	Very bad
Overall acceptability	Very acceptable	Moderately acceptable	Neither acceptable nor unacceptable	Moderately unacceptable	Very unacceptable

Table 2: Effects of ginger extracts on the chemical composition and physical properties of yoghurt

Parameters	Treatments							p-value
	T1	T2	T3	T4	T5	T6	T7	
Fat (%)	2.677^{d}	1.525^{e}	3.571^{abc}	3.739^{ab}	4.103^{a}	3.119^{cd}	3.246^{bc}	0.000
Protein	3.518^{a}	3.560^{a}	3.409^{a}	3.499^{a}	3.854^{a}	3.599^{a}	3.487^{a}	0.599
Ash (%)	0.693^{b}	0.697^{b}	0.725^{ab}	0.698^{b}	0.779^{ab}	0.765^{ab}	0.800^{a}	0.006
pH	3.46^{a}	3.48^{a}	3.49^{a}	3.48^{a}	3.49^{a}	3.49^{a}	3.49^{a}	0.437
Viscosity	602.34^{ab}	412.62^{d}	328.22^{e}	243.08^{f}	628.43^{a}	560.58^{bc}	516.67^{c}	0.000
TSS	15.87^{a}	16.05^{a}	15.70^{a}	15.75^{a}	16.27^{a}	16.47^{a}	16.88^{a}	0.166

Mean values in a row across treatments with different superscripts are significantly different (P<0.05).
TSS: Total soluble solids

There were no significant differences (P>0.05) in the protein contents of the various treatments. Ash content (an indicator of total amount of minerals present in the yoghurt samples) had significant differences (P<0.05). Ash content generally increased linearly with the addition of both ginger extract and powder with T_7 (spiced yoghurt with 1.5% ginger powder) recording the highest ash content (Table 2). Thus the addition of ginger increased the ash content with higher levels of ginger registering higher levels of ash. This observation was similar to the results of Pagthinathan and Tharmiga (2017) when the authors added ginger paste to yoghurt.

It can also be seen from Table 2 that the pH of all treatments was not affected by the introduction of both ginger extract and powder in yoghurt though an observation was recently made by Amadou *et al*. (2018) that the pH of yoghurt depends on the milk composition, the ingredients used and the activity of lactic acid bacteria in converting lactose to lactic acid.

There were significant differences (P<0.05) in the viscosity of yoghurt samples. Viscosity values decreased from 412.62 (T2) to 243.08(T4) with increase in the concentration of the ginger juice used indicating that addition of the juice clearly reduced the thickness and dry matter of the yoghurt samples thereby decreasing their viscosity. Interestingly the inclusion of 0.5% ginger powder in T_5 resulted in the highest viscosity value which then declined linearly with increase in ginger powder to 516.67. Similar results were obtained by Amadou *et al.* (2018) with the addition of fruit puree to yoghurt which resulted in reduced viscosity. According to the authors, their result could be related to the dry matter content of the samples. In fact, the viscosity of yoghurt increases with yoghurt dry matter. According to Early (1998), the viscosity of yoghurt is usually enhanced by the addition of stabilizers and thickeners such as natural starches, alginates, agar, carrageenan, edible gums and celluloses, none of which was used in this study.

The total soluble solids (TSS) of all the yoghurt samples showed no significant differences (P>0.05) as shown in Table 2. The physicochemical composition of yoghurt depends generally on many factors including the milk composition and various additives used, their mode of formulation by the manufacturer and the processing technology involved.

Effect of ginger extracts on the sensory parameters and total viable count of yoghurt samples

There were significant differences (P<0.05) in all the parameters evaluated (Table 3) except for microbial cell count. In terms of appearance, the control and the treatments spiced with ginger juice scored higher (P<0.05) than those spiced with ginger powder. Consequently, the appreciation of the appearance of the samples spiced with 0.5%, 1.0% and 1.5% ginger powder were

Table 3: Effect of ginger extracts on the sensory parameters and total viable count of yoghurt

Parameter	Treatment							P-value
	T1	T2	T3	T4	T5	T6	T7	
Appearance	1.37^{a}	1.23^{a}	1.33^{a}	1.47^{a}	2.43^{b}	2.67^{b}	2.57^{b}	0.000
Mouthfeel	1.67^{a}	1.80^{a}	2.07^{a}	1.97^{a}	3.17^{b}	3.47^{b}	3.80^{b}	0.000
Flavor	2.87^{b}	2.57^{ab}	2.63^{b}	2.77^{b}	2.77^{b}	2.17^{ab}	3.77^{c}	0.001
Taste	2.60^{ab}	2.83^{a}	3.07^{ab}	3.20^{ab}	3.20^{ab}	3.50^{bc}	3.90^{c}	0.000
Acceptability	1.70^{a}	2.50^{ab}	3.10^{bc}	3.60^{c}	4.10^{d}	4.67^{de}	4.33^{e}	0.000
TVC(cfu/ml)	11.54	7.87	10.47	9.83	7.85	7.05	8.87	0.470

Mean values in a row across treatments with different superscripts are significantly different (P<0.05).
Scale: score of 1 is better that 5

low. This could be attributed to the brownish coloration of the powder which slightly affected the original plain color of yoghurt. The results for mouthfeel followed a similar trend where the control and those spiced with the different levels of ginger juice were scored better than those spiced with ginger powder.

The results showed that mouthfeel of yoghurt was similar for T1 and all those produced with ginger extract, but the use of ginger powder resulted in significantly ($p<0.05$) lower perceptions of mouthfeel compared to the control and treatments produced with ginger extract. The liquid form of the ginger reduced the firmness of the yoghurt slightly and subsequently its texture by dilution. At lower proportions of the extract, the dilution effect is however low and this could justify the similarity of mouthfeel values between the control and those spiced with 0.5%, 1.0% and 1.5% ginger juice. In the case of the ginger powder, it thickened the yoghurt and made the texture rough as it was increased from 0.5% to 1.5% which unfortunately was not much appreciated by the panelists.

For flavor, all spiced yoghurt samples showed similar mean scores with the control, except for T7 (1.5% ginger powder) which recorded a higher mean score of 3.77 for flavor, indicating that it was very strong. The taste of all the other treatments generally recorded similar values. The results also showed that there was a significant ($p<0.05$) reduction in the appreciation of taste of yoghurt which was related to increasing concentrations of the ginger used. Ginger in any form is characterized by a pungent taste. Thus, at higher concentrations it manifested by reducing the original taste of yoghurt.

All the spiced yoghurt samples differed ($P<0.05$) in terms of acceptability, with the acceptability decreasing linearly with increase in ginger juice and powder concentrations. These results were in accordance with results of Amadou *et al.* (2018) in a similar study. Product acceptability is determined by how consumers perceive its appearance, taste, texture and flavor, all of which reduced significantly ($p<0.05$) with increasing use of ginger in yoghurt. But it was observed that the acceptability of the control was not significantly ($p<0.05$) different from yoghurt produced with 0.5% ginger extract because the consumer panel in this study could not differentiate between T1 and T2 in terms of appearance, taste, mouthfeel and flavor appearance.

The effect of ginger extracts on total viable count of yoghurt samples are also shown in Table 3. There was no significant difference ($P>0.05$) among the treatments. The addition of ginger extracts decreased the Total Viable Count numerically but the differences were not significant ($P>0.05$). According to Tamime and Deeth (1980), quantitative standards for yoghurt bacteria differ. However, it is generally accepted that yoghurt could contain 10^7 CFU of viable bacteria (S. thermophilus and L. bulgaricus) per ml (Chougrani et al., 2009).

Comparing the results in Table 3 to this standard, it can be seen that the bacteria load of samples T_2, T_5 and T_6 were within the acceptable

limit. However, T_1, T_3, T_4 and T_7 yoghurt samples presented high plate count values than the standard. Micro- organisms used as starter culture may have contributed to the total bacterial count of these yoghurt samples. Also the source (farm to market) of the spice (ginger) may have contributed to the total bacterial count which was above those of the plain yoghurts.

CONCLUSIONS

The results of this study showed that ginger extract had no effect on pH, total soluble solids and protein of yoghurt but decreased its fat content and viscosity with increased concentrations. Ginger however had an effect on the ash content of yoghurt as it generally increased with increased concentrations of the ginger extract.

Yoghurt without the inclusion of ginger extract was similarly preferred compared to those produced by addition of ginger extract at levels higher than 0.5%. Accordingly, spicing yoghurt with 0.5% of ginger extracts during preparation could be recommended for human consumption without any adverse effects on nutritional benefits and sensory perceptions.

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