Physicochemical and Sensory Properties of Ginger Spiced Yoghurt

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Abstract: The physicochemical and sensory properties of ginger spiced yoghurt were investigated in the present study. Four yoghurt samples: A, B, C and D were prepared by addition of 0, 0.5, 1 and 1.5% (W/V) of ginger powder. Physicochemical properties of yoghurt samples determined at day 0 included pH, titratable acidity, dry matter, ash, fat and non-fat solid (NFS). The pH and titratable acidity were also evaluated during 30 days of storage at refrigerated conditions (4 – 6°C). The sensory attributes assessed were colour, odour, taste, texture and overall acceptability. From the results, ginger powder did not affect (P>0.05) the pH and titratable acidity of yoghurt but increased (P≤0.05) the dry matter, fat, NFS and ash content especially when spiced at 1% and 1.5% level. The spiced yoghurt did not show significant changes (P>0.05) in titratable acidity during storage as opposed to the unspiced yoghurt that increased (P<0.05) with storage time. The pH values of spiced yoghurt were not significantly affected (P>0.05) by storage contrary to the unspiced yoghurt. At the end of storage, the unspiced yoghurt presented the lowest (P≤0.05) pH and the highest (P≤0.05) titratable acidity. Results of sensory evaluation revealed the low appreciation of the spiced yoghurt with an increase in the proportion of ginger powder. However, yoghurt with 0.5% ginger powder was appreciated equally (P>0.05) with the unspiced sample. Spicing yoghurt with ginger powder therefore has positive effect on its physicochemical properties and shelf –life. The yoghurt spiced with 0.5% ginger powder could therefore be recommended.

Keywords: Yoghurt, ginger powder, physicochemical properties, sensory properties, storage.

INTRODUCTION

Dairy products are widely consumed all over the world due to their health benefits in addition to their nutritive value [1]. Amongst fermented milk product, yoghurt is the most consumed worldwide [2, 3]. Yoghurt is an acidified coagulated milk product obtained by fermentation in the presence of thermophilic lactic acid bacteria known as *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. It has an important role in human nutrition. It represents an excellent source of proteins, vitamins and minerals [4] and it is recommended for people with lactose intolerance due to the degradation of lactose into lactic acid during fermentation. Moreover, yoghurt reduces risk of diseases and improves gut health [5]. Although yoghurt has high nutritive value, it is not a perfect food for human nutrition [6, 7]. It has a short shelf-life. Moreover, it is necessary to diversify the form of consumption by adding many different and important functional ingredients. Incorporation of fruits during yoghurt production has contributed to improve its nutritional quality [8] in addition to other health benefits. Spices are plants rich in bioactive components with health benefits and they constitute a potential source of minerals and vitamins although their utilization in yoghurt making has not been well exploited.

Ginger (*Zingiber officinale*. Roscoe) is commonly used as a spice. It is characterised by its pungent taste and represents a potential source of fibres, proteins, minerals and essential amino acids [9, 10]. It has a wide application in the area of food bio–fortification and could be exploited in new food formulation [9]. It has been used since ancient times in traditional medicine in Asia. Ginger has many active phytochemical compounds which are biologically active. Gingerols are the main active component in ginger and the 6-gingerol is the most important [11]. It intervenes in the treatment and prevention of many diseases such as cancer. Many studies indicated that ginger is endowed with antibacterial and antifungal properties [12-14]; hypoglycaemic, hypolipidemic and hypocholesterolemic properties [15-18] and antioxidant and anti-inflammatory effects [19, 20]. It also improves gastro-intestinal function [11, 21]. Due to its antimicrobial properties, ginger could increase the shelf life of foods [22].

The use of ginger to spice yoghurt could therefore confer some beneficial effects on the yoghurt. The aim of the present study therefore is to evaluate the

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physicochemical and sensory characteristics of ginger spiced yoghurt.

MATERIAL AND METHODS

Preparation of Ginger Powder

The roots (rhizomes) of ginger (*Zingiber officinale*) originating from Bafut (Bafut Sub-Division. Mezam Division. North-West Region. Cameroon) were purchased from the Bamenda Food Market in the North-West Region of Cameroon and brought to the Food Technology Laboratory of the Regional Centre of IRAD – Bambui, Cameroon. The ginger was washed several times with tap water (Portable water). Then, it was peeled, rewashed with tap water, sliced into small sizes of 2- 3 diameter thick and dried in a vacuum oven at 60 – 65°C for 72hours [10]. The dried ginger was blended into powder using a kitchen blender. The powder obtained was sieved using a sieve of pore size ≤ 300µm. The sieved ginger powder was stored in plastic bags at room temperature in a closed cupboard to avoid UV light.

Preparation of Ginger Spiced Yoghurt

Fresh cow's milk (Physicochemical composition given in Table **1**) collected from the dairy unit of the research centre of IRAD Bambui was used to produce four yoghurt samples in five replicates. The yoghurt was made according to the modified method of Lee and Lucy [23]. The milk was pasteurised by heating at 85-90°C for five minutes in a boiling water bath during which 6.5% (w/v) of sugar was added. The milk was then rapidly cooled to inoculation temperature (42 – 45°C) followed by addition of 2.5% (w/v) yoghurt starter culture (CHR HANSEN YF – L811) comprised of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* in a 1:1 ratio and incubated at 42 - 45°C for 3hours when the yoghurt was set. The set yoghurt was directly cooled in refrigerator (4 – 6°C for 6 to 12 hours) before manual stirring. The four yoghurt samples: A, B, C and D were prepared by addition of 0, 0.5, 1 and 1.5% (W/V) of ginger powder (90.91±0.34% DM and 4.26±0.07% ash) respectively to the stirred yoghurt and kept in a refrigerator (4 – 6°C) for further analysis. All samples were subjected to physicochemical analysis and sensory evaluation.

Physicochemical Analysis

The physicochemical analysis of each sample was done in duplicate. The dry matter (DM), pH. Titratable Acidity (TA), ash and fat were determined according to the standard Association of Official Analytical Chemists methods [24]. The pH and TA were also done on samples exposed to 30 days of storage at refrigerated conditions (4 – 6°C) at 5 days' intervals. The Non-Fat Solid (NFS) was obtained from the fat content following the formula: NFS (%) = dry matter (%) – fat content (%).

Sensory Evaluation

Sensory evaluation of all the yoghurt samples were carried out using a five-point hedonic scale with the following as categories: Excellent=5; Very Good=4; Good=3; Fair=2 and Poor=1. Colour (appearance), flavour (aroma), texture, taste and overall acceptability of yoghurt samples were evaluated by an untrained panel of 34 persons between 20 and 60 years old who were regular yoghurt consumers and made of researchers, technicians and students on internship at IRAD Bambui.

Statistical Analysis

Data obtained were subjected to the Analysis of variance (ANOVA) using the Statgraphics Plus (version 5.0) statistical package and results expressed as Mean ± standard deviation. The means obtained were separated using the Fisher's Test ($P \leq 0.05$).

RESULTS AND DISCUSSION

Physicochemical Analysis

The physicochemical composition of the ginger spiced yoghurt is presented in Table **2**. The pH of all the yoghurt samples were not significantly different ($P \geq 0.05$). Thus, ginger powder did not affect the yoghurt pH and it could be due to the low proportion used. This result is not in line with those of some

Table 1: Physicochemical Composition of Fresh Cow Milk Used for Yoghurt Production

pH	(%)						
	TA	DM	Ash	Fat	Proteins	Lactose	NFS
6.73±0.05	0.45±0.04	13.7±0.23	0.68±0.06	5.1±0.12	3.4±0.11	4.61±0.25	8.7±0.14

Values are Mean ±standard deviation (n=5); TA: Titratable Acidity; DM: Dry Matter; NFS: Non-Fat Solid.

authors [25-27] that obtained a reduction of yoghurt pH with addition of pineapple, honey and sapota and this may be due to the fermentable sugars and organic acids present in these products. Studies on different fruit flavoured yoghurt showed a reduction of yoghurt pH with addition of 10% strawberry compared to other fruits (Banana and apple) [28]. The pH values obtained were similar to the normal pH value of yoghurt which is between 4.0 and 4.1 and are within the standard range for yoghurt which is ≤4.6 [29]. The pH values obtained are consistent with those of popular Turkish yoghurt and artisanal Cameroonian yoghurt [30, 31]. Nevertheless, they are higher than those of pineapple flavoured yoghurt and yoghurt present on the Nigerian market [25, 32]. On the other hand, it is lower than the values obtained for yoghurt from fresh milk (Cow and camel) and fruit flavoured yoghurt [28, 33]. The pH of the yoghurt depends on the milk composition, the ingredients used and the activity of lactic acid bacteria. It also depends on the type of fruits or spices used [34] due to the degree of acidity and its composition (fermentable sugars, organic acid contents, etc.).

Titratable acidity of yoghurt was not affected by addition of ginger powder (P≥0.05). This could be related to the low quantity of ginger powder used and the low organic acid content of ginger. Previous studies did not reveal the same trend [25-28]. These studies rather indicated increasing titratable acidity with addition of fruits or honey to yoghurt. Fruits or honey have fermentable sugars which serve as substrate to lactic acid bacteria with production of lactic acid in addition to their organic acid components leading to an increase of titratable acidity. The titratable acidity values were in accordance with the normal value (0.9 – 1%) and the values proposed by FDA [29], USDA [35] and Turkish legislation [36]. They were seemly higher than results from previous studies [25, 32], lower than those of other authors [30, 36] and, similar to those of Yousef *et al.* and. Elfaki and Abd Elrazig [28, 37]. The titratable acidity of yoghurt depend mostly on the activity of lactic acid bacteria which also depends on the availability of nutrients and water activity.

The unspiced yoghurt (Sample A) showed the lowest dry matter content and the value obtained were comparable (P>0.05) to that of yoghurt spiced with 0.5% (W/V) ginger (sample B). Generally, increasing of ginger powder resulted to the increase in dry matter originating from the ginger powder (90.91±0.34%). Other studies obtained similar result with addition of fruit (Banana, apple and strawberry) marmalade made with 30% of sugar and 70% of fruit pulp, pineapple puree (21.50% dry matter) and honey [25, 26, 28]. However, another author observed on the other hand no significant change between plain and fruit yoghurt samples collected from retail outlets in Sabaragamuwa Province of Sri Lanka [38]. The amount of dry matter in yoghurt depends on the amount and the nature of fruits and herbs used [34]. Similar values of dry matter were observed [25, 31, 32] and, also seemingly higher [26] and lower [30, 33, 37, 39] values. The difference observed could be related to many factors including the milk composition as well as the quantity and the nature of ingredients used.

Yoghurt spiced with 1.5% (W/V) ginger (Sample D) showed the highest ash content amongst all the samples but not significantly different (P>0.05) from yoghurt spiced with 1% (W/V) ginger (sample C). The increase in ash content of yoghurt could be related to the ash content of ginger powder (4.26±0.07%). This trend was also obtained with addition of marmalade fruit (0.43 to 1.10% ash), banana with the high ash content had the best result [28]. It was in contrast to other results obtained for pineapple puree [25] and this might be due to the low ash content of the pineapple puree used (0.20%). Some other studies obtained similar result [36] with some having no significant changes between the fruit and the plain yoghurt in terms of ash content [38]. The ash content values

Table 2: Physicochemical Composition of Ginger Spiced Yoghurt

Samples	pH	TA (%)	DM (%)	Ash (%)	Fat (%)	NFS (%)
A	4.18±0.13^{a}	1.01±0.06^{a}	18.72±0.37^{c}	0.68±0.01^{c}	4.76±0.08^{c}	13.96±0.37^{b}
B	4.18±0.13^{a}	1.01±0.05^{a}	19.0±0.36^{bc}	0.69±0.01^{bc}	4.88±0.08^{bc}	14.12±0.39^{b}
C	4.20±0.15^{a}	1.04±0.05^{a}	19.48±0.35^{ab}	0.72±0.00^{ab}	5.04±0.05^{b}	14.44±0.33^{ab}
D	4.24±0.11^{a}	1.02±0.06^{a}	19.96±0.39^{a}	0.76±0.01^{a}	5.22±0.04^{a}	14.74±0.39^{a}

Values are mean ± standard deviation (n=5).
(a, b, c): the values with the same superscript letter in the same column are not significantly different (P>0.05).
Sample A: Unspiced yoghurt, Sample B: Yoghurt spiced with 0.5% of ginger powder, Sample C: Yoghurt spiced with 1% of ginger powder, Sample D; Yoghurt spiced with 1.5% of ginger powder. TA Titratable Acidity; DM: Dry Matter; NFS: Non - Fat Solid.

obtained were comparable to those of previous works [25, 28, 31, 33], lower than values obtained by Güler and Park [30] and, higher than values of Elfaki and Abb Elrazig [37] and Joseph *et al*. [32]. The difference observed could be attributed to the milk composition, the nature and the amount of ingredients used in the process.

Yoghurt spiced with 1.5% (W/V) presented the highest (P≤0.05) fat content amongst all the samples while the unspiced yoghurt as well as those spiced with 0.5% ginger had the lowest. Increasing of ginger powder concentration resulted to an increase in the fat content. This could be related to the fat content of ginger powder. A reduction of yoghurt fat in presence of fruits or honey were observed in other studies [25-28, 36, 38]. This is attributed to the low fat content, characteristic of fruits and honey. Similar values of yoghurt fat content were also obtained [30] while other findings showed higher [39] and lower [25, 31, 32, 36-38] values. These differences could be due to the milk composition (fat content) and the nature and the quantity of ingredients added.

The non-fat solid (NFS) value of Yoghurt spiced with 1.5% (W/V) ginger was comparable (P>0.05) to that spiced with 1% ginger and higher (P≤0.05) than the unspiced and 0.5% spiced yoghurt. This could be explained by the high proportion of non-fat solid in ginger powder. Similar result was observed by using fruits with low fat content and consequently high NFS content [25, 27] contrary to other studies which did not have significant differences in NFS content with fruit and plain yoghurt [38]. The values obtained are higher than results reported by other authors [28], similar to those from previous findings [25, 32] and lower than studies by De Silva *et al*. [38]. The NFS of yoghurt is related to the fat content of the ingredient and the quantity used.

In general. physicochemical properties of yoghurt depends on many factors including milk composition, technology used, nature and composition of additives, strains and activity of lactic acid bacteria.

pH of Ginger Spiced Yoghurt During Storage

Figure **1** presents the changes in pH of yoghurt samples during 30 days of storage. The changes observed were consistent for all the samples studied. The changes of pH values obtained were not significant (P≥0.05) from the beginning of storage but from day 25 to day 30 for the unspiced yoghurt sample, a significant drop in pH was noticed. The unchanged pH till day 25 of storage could be due to the insignificant activity of lactic acid bacteria. This result is in accordance with studies using Thai fruits (pineapple, pawpaw and mango) to flavour yoghurt and stored for 21 days [40] but not with that of other authors [25, 27, 28, 33, 36, 37] which indicated reduction of yoghurt pH from the beginning of storage till 15 days. During storage, and in refrigerated conditions, activity of lactic acid bacteria is not completely stopped and there is production of lactic acid leading to a drop of pH. The pH values of all the yoghurt samples remained the same (P>0.05) but at the end of storage, the unspiced yoghurt showed the lowest (P≤0.05) pH value while yoghurt sample spiced with 1.5% (W/V) and that spiced with 1% (W/V) ginger had the highest. The high value (P≤0.05) observed for the spiced yoghurt samples compared to the unspiced yoghurt sample at the end of storage could be as a result of low level of fermentation due to the antimicrobial activity of the ginger, thus the ginger could contribute to the preservation of yoghurt. The significant difference (P≤0.05) between the initial and

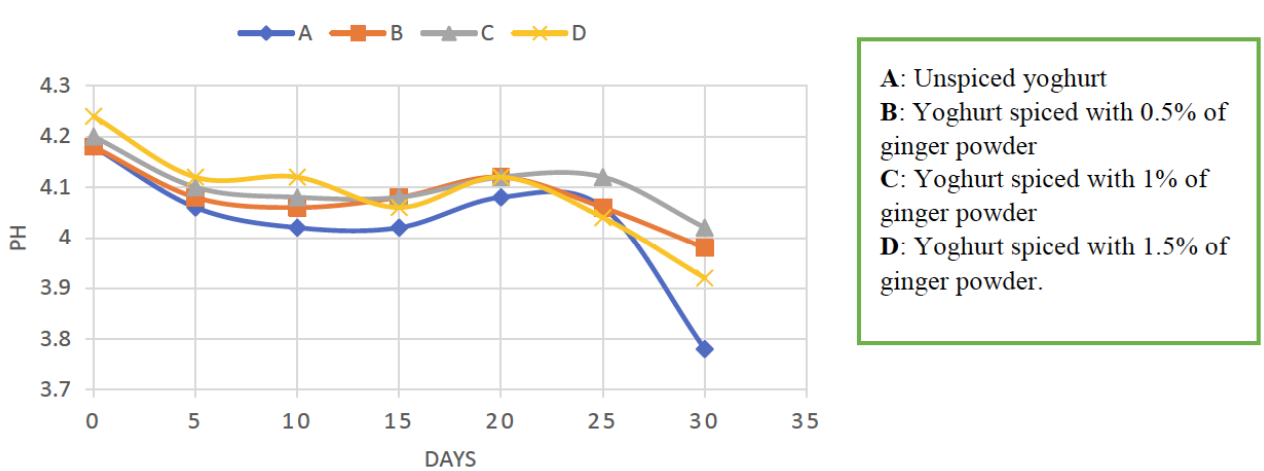

Figure 1: pH of ginger spiced yoghurt during 30 days of storage.

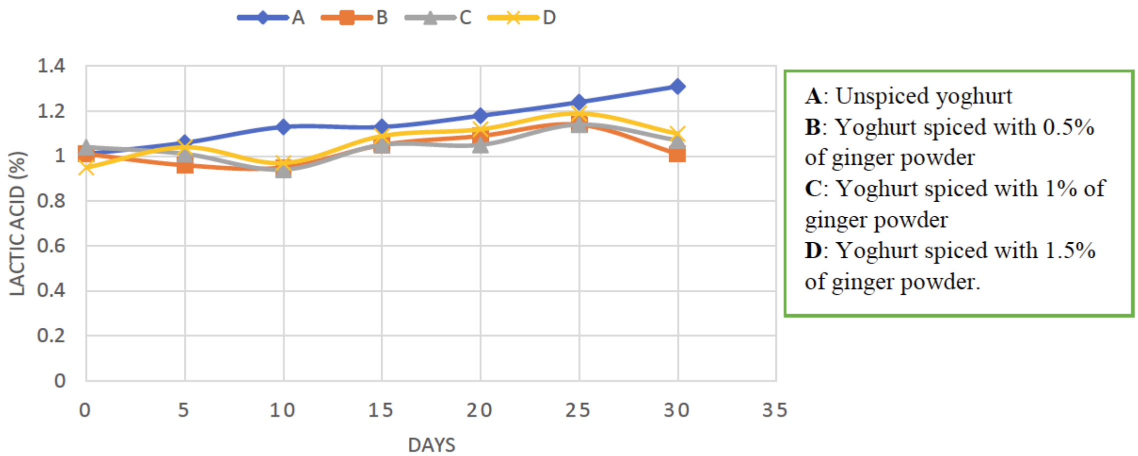

Figure 2: Titratable acidity (% lactic acid) of ginger spiced yoghurt during 30 days of storage.

the final values of yoghurt samples pH could also be related to the continuous fermentation at refrigerated conditions.

Titratable Acidity of Ginger Spiced Yoghurt During Storage

From Figure **2**, there is a regular increase (P≤0.05) in titratable acidity of the unspiced yoghurt sample during storage while the variations observed with other samples were not significant (P≥0.05). Moreover, the unspiced sample presented the highest titratable acidity (P≤0.05) especially on day10, day 25 and at the end of storage. For spiced samples, the initial and the final values of titratable acidity were similar (P≤0.05) while those of unspiced sample were different (P≥0.05). The increase of titratable acidity obtained with the unspiced sample was due to fermentation (activity of lactic acid bacteria) which is not completely stopped during refrigeration thus leading to the production of lactic acid. This result corroborates with previous studies [25, 27, 28, 33, 36, 37]. The antimicrobial activity of ginger could be responsible for the non - significant variation of titratable acidity in the spiced yoghurt samples during storage. The high titratable acidity of unspiced sample compared to spiced samples could indicate a positive effect of ginger on the preservation of yoghurt.

Sensory Evaluation

Results of sensory evaluation reported in Table **3** show that the unspiced yoghurt obtained the highest (P≤0.05) preference score in colour, odour and taste. However, no significant difference (P≥0.05) was obtained between this sample and that spiced with 0.5% ginger for texture and overall acceptability. In general, increasing the quantity of ginger powder in yoghurt significantly decreased the sensory properties of yoghurt and reduced its overall acceptability. The ginger powder is characterised by its flavour, pungent taste and brownish colour which modify the original colour, odour and taste of yoghurt, thus reducing its appreciation by panellists. Moreover, because starch is the main carbohydrate component in ginger and it is used as thickener and gelling agent, its action could be high at certain levels of concentration and thus justify the loss of original texture in samples spiced with higher levels of powder (1 and 1.5% W/V). Similar overall acceptability of yoghurt spiced with low level of

Table 3: Sensory Evaluation Scores of Ginger Spiced Yoghurt

Samples	Colour	Odour	Taste	Texture	Overall acceptability
A	4.00 ± 0.81^{a}	3.61 ± 1.04^{a}	3.82 ± 0.90^{a}	3.64 ± 0.94^{a}	3.76 ± 0.95^{a}
B	2.79 ± 0.91^{b}	3.17 ± 0.99^{b}	3.17 ± 0.96^{b}	3.35 ± 0.84^{a}	3.44 ± 0.78^{a}
C	2.11 ± 0.80^{c}	2.58 ± 0.70^{c}	2.38 ± 0.65^{c}	2.79 ± 0.80^{b}	2.70 ± 0.71^{b}
D	1.82 ± 0.93^{c}	2.41 ± 0.82^{c}	1.76 ± 0.81^{d}	2.38 ± 0.98^{c}	2.11 ± 0.91^{c}

Values are mean ± standard deviation (n=5).
(a, b, c): the values with the same superscript letter in the same column are not significantly different (P>0.05).
Sample A: Unspiced yoghurt, Sample B: Yoghurt spiced with 0.5% of ginger powder, Sample C: Yoghurt spiced with 1% of ginger powder, Sample D: Yoghurt spiced with 1.5% of ginger powder.

ginger powder (0.5% (W/V)) and unspiced yoghurt could be explained by the low impact of ginger on the sensory properties of the yoghurt.

CONCLUSION

Ginger powder incorporated to yoghurt has no effect on titratable acidity and pH of the yoghurt while it increases its dry matter, fat, NFS and ash content especially at higher concentrations (1 and 1.5% (W/V)). During storage, it positively affects the change of pH and titratable acidity. The use of ginger powder in yoghurt making reduces the sensory characteristics of yoghurt but at 0.5% (W/V), no significant effect is observed in the acceptability of the yoghurt.

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