Available online at http://www.journalijdr.com

IJDR

ISSN: 2230-9926

International Journal of Development Research
Vol. 08, Issue, 05, pp.20468-20477, May, 2018

ORIGINAL RESEARCH ARTICLE **OPEN ACCESS**

EFFECT OF GINGER EXTRACT ON THE PHYSICOCHEMICAL AND SENSORY PROPERTIES OF YOGHURT

[1,*]Njoya Moyouwou Amadou, [2]Ejoh Aba Richard, [3]Kuiate Jules – Roger, [1]Nain Caroline Waingeh, [2]Kuboh Delphine Ateh, [2]Audra Faison Mbiydzengeh, [1]Nde Sylvanus Che and [1]Mahbou Peter Yunenyui

[1]Food Technology and Post–Harvest laboratory, Irad–Bambui; P.O.Box 51 or 80 Bamenda, Cameroon
[2]Department of Food and Bioressource Science and Technology, Coltech – University of Bamenda; P.O. Box 39 Bambili, Cameroon
[3]Department of Biochemistry, Faculty of Science – University of Dschang; P.O. Box 67 Dschang, Cameroon

ARTICLE INFO

Article History:
Received 28th February, 2018
Received in revised form
10th March, 2018
Accepted 27th April, 2018
Published online 31st May, 2018

Key words:
Yoghurt, ginger extracts, Physicochemical And sensory Properties, storage.

ABSTRACT

The aim of this study was to evaluate the effect of ginger extracts on the physicochemical and sensory properties of yoghurt. Six ginger extracts were obtained by decoction, maceration at room temperature and at refrigerated conditions (4- 6°C) of ginger paste and powder.Yoghurt were obtained by adding each extract at0%, 5%, 10% and 15% (V/V).Physicochemical properties of yoghurt samples (pH, titratable acidity, dry matter, ash, fat, and non-fat solid) were determined at day 0. The pH and titratable acidity were also evaluated during 30 days of storage at refrigerated conditions at 5 days' intervals. The sensory attributes assessed were colour, odour, taste, texture and overall acceptability. From the results,ginger extractsdid not affectthe pH of yoghurt but decreased the titratable acidity, dry matter, fat, non-fat solid (NFS) and ash at high concentrations. Ginger extracts did not also affect the titratable acidity and the pH of yoghurt during storage. Addition of ginger extract at levels higher that 5% led to the reduction of the level of appreciation of yoghurt by the panellist but at 5%, no effect was observed. Spicing the yoghurt with 5% of ginger extract during its manufacturing could therefore be recommended for human consumption.

Citation: Njoya Moyouwou Amadou, Ejoh Aba Richard, Kuiate Jules – Roger *et al.*, 2018. "Effect of ginger extract on the physicochemical and sensory properties of yoghurt", *International Journal of Development Research*, 8, (05), 20468-20477.

INTRODUCTION

Yoghurt is the most popular fermented dairy product all over the word (Tamine and Deeth, 1980; Madhu *et al*., 2012). It is a semi - solid product obtained through lactic acid fermentation of milk. During fermentation, lactose of milk is transformed into lactic acid by lactic acid bacteria known as *Lactobacillus bulgaricus*and *Streptococcus thermophilus*. Yoghurt represents an excellent source of proteins, minerals and vitamins (Buttris, 1997). It is more digestible than milk due to the partial or total hydrolysis of fat, lactose and proteins and therefore recommended for people with lactose intolerance or milk proteins allergy. Moreover, yoghurt endowed health benefits including reduction of risk of diseases and improvement of health gut, lowering blood cholesterol level, improvement of immune response and helping assimilation of protein, calcium and iron (Perdigeon *et al.*, 1998; Heymans, 2000; Marona and Pedrigon, 2004). Yoghurt quality depends on the change observed on its physiochemical, microbiological and sensory characteristics. In addition, its shelf-life is limited due to the deterioration of its properties during storage. In order to improve the yoghurt quality, different flavouring ingredients have been added during its manufacturing. Mostly, artificial flavours are used while, the use of natural flavours could be more benefits to the consumer. Addition of herbs could be an effective strategy toimprove functionality of milk and milk products with respect to the health benefits, food safety andbio-preservation (Aswal *et al.*, 2012). Thus, natural fruits as flavour have contributed to improve the level of consumption of yoghurt due to their nutritive value in addition to their health benefits, flavour and aroma. The use of spices as flavour during yoghurt manufacturing could also be useful considering the fact that, they are plants rich in bioactive components with health benefits and constitute a potential source of minerals and vitamins. In addition, they are

***Corresponding author:* Njoya Moyouwou Amadou,**
Food Technology and Post–Harvest laboratory, Irad–Bambui; P.O. Box 51 or 80 Bamenda, Cameroon.

characterised by their antimicrobial properties and could consequently positively affect the shelf life of yoghurt. Ginger (*Zingiberofficinale*, Roscoe) is a spice commonly used culinary for its taste, aroma and flavour. Traditionally, it aids against gastrointestinal disorders as antispasmodic in stomach aches and diarrhoea and has been used since ancient times as traditional medicines in Asia. It is characterised by its pungent taste and represents a potential source of fibres, proteins, minerals and essential amino acids (Latona*et al*., 2012; Olubunmi *et al*., 2013). It has many bioactive components, and amongst gingerols, the main active component, the 6-gingerol is the most important (ICMR, 2003). It helps in the treatment and prevention of many types of cancer. Many studies indicated that ginger is endowed with antibacterial and antifungal properties (Gugnani and Ezenwanze, 1985; Akoachere *et al*., 2002; Atai *et al*., 2009; Kaushik and Goyal, 2011); hypoglycaemia, hypolipidemia and hypocholesterolaemia properties (Ahmed and Sharma, 1997; bhandari *et al*., 2005; Al-Amin *et al*., 2006; Mendi, 2011) and antioxidant and anti-inflammatory effects (Aruoma*et al*., 1997; Thomson *et al*., 2002). It also improves gastro-intestinal function (Guyer, 2003; ICMR, 2003). Furthermore, ginger and its extracts have pharmacological, digestion stimulant and antimicrobial activities. Due to its antimicrobial nature, ginger could increase the shelf-life of foods (Adesokan *et al*., 2010). The use of ginger to spice yoghurt could therefore be benefit and render the yoghurt more functional. Thus, the present study is to investigate on the effect of ginger extracts on the physicochemical and sensory properties of yoghurt.

MATERIAL AND METHODS

Preparation of ginger powder: The roots (rhizomes) of ginger (*Zingiberofficinale*) 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 (Potable water). Then, it was peeled, rewashed using tap water, sliced into small sizes of 2- 3mm diameter thick and dried in a vacuum oven at 60 – 65°C for 72hrs (Olubunmi *et al*., 2013). The dried ginger was blended into powder using a kitchen blender. The powder obtained was then sieved using a sifter of pore size ≤ 300µm. The sieved ginger powder was put in plastic bags, stored at room temperature under unlight.

Preparation of ginger paste: The ginger paste was obtained after successively washing, peeling, rewashing and grating of the ginger roots.

Preparation of ginger aqueous extract: Ginger extracts was obtained from ginger powder and ginger paste by modified methods described by Kaushik and Goyal (2011) and Abd El – Aziz *et al.* (2015).

Decoction: Decoction was done by boiling 100g of ginger paste in 3.2l of potable water (drinkable water)till one fourth (1/4) of the initial volume was attained. The solution was filtered twice using a muslin cloth, then allowed at room temperature for sedimentation and the supernatant collected. The same procedure was used with ginger powder but using 100g in 4l of drinkable water.

Maceration: Maceration was done by soaking 100g of ginger paste for 1h in 800ml of hot drinkable water firstly boiled and cooled at 80°C for 1hr. After cooling at room temperature, the mixture was then allowed at refrigerated conditions (4 - 6°C) for three (03) days and filtered twice using a muslin cloth. Maceration was also done at room temperature for three (03) days. Ginger powder was also macerated as indicated above with ginger paste but using 100g of powder in 1l of drinkable water. All the extracts collected was pasteurised at 75°C/3 – 5s, cooled at room temperature and kept in the freezer at ≤0°C for further uses.

The following extracts were obtained

- **Extract 1:** Maceration of ginger paste at refrigerated conditions
- **Extract 2:** Decoction of ginger paste
- **Extract 3:** Maceration of ginger paste at room temperature
- **Extract 4:** Decoction of ginger powder
- **Extract 5:** Maceration of ginger powder at refrigerated conditions
- **Extract 6:** Maceration of ginger powder at room temperature.

Preparation of ginger spiced yoghurt: Fresh cow's milk (Physicochemical composition given in table 1) collected from the dairy unit of the research centre was used to produce yoghurt samples in five replicates. The yoghurt was made according to the modified method of Lee and Lucey (2010). The milk was pasteurized 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) comprising *Streptococcus thermophilus*and *Lactobacillus bulgaricus* in a 1:1 ratio and incubation at 42 - 45°C for 3h when the yoghurt was set. The set yoghurt was directly cooled in refrigerator (4 – 6°C for06 – 12h) before manual stirring. After stirring, each ginger extract has been added to the yoghurt at different concentrations (0,5, 10 and 15% (V/V)). 19 yoghurt samples were then obtained as indicated in Table 2. All the yoghurt samples were kept in the refrigerator (4 – 6°C) for 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 (AOAC, 1990). The pH and TA determination were also done within 30 days of storage at refrigerated conditions (4 – 6°C) and at 5 days' intervals. The Non-Fat Solid (NFS) was obtained using the formula: NFS (%) = dry matter (%) – fat content (%).

Sensory evaluation: Sensory evaluation of all yoghurt samples was 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), odour, texture, taste and overall acceptability of yoghurt samples were evaluated by an untrained panel of 30 persons between 20 and 60 years old who were regular yoghurt consumers and made of researchers, techniciansand students on internship of the centre of IRAD – Bambui.

Statistical analysis: Data obtained were expressed as Mean±SD and subjected to the Analysis of variance (ANOVA) using the Statgraphics Plus, version 5.0 statistical package.
The means obtained were separated using the Fischer Test (P≤0.05).

RESULTS AND DISCUSSION

Physicochemical analysis: The physicochemical composition of the yoghurt samples is shown in Table 3. The results indicate that pH of yoghurt was not affected (P>0.05) by the ginger extracts. This could be due to the aqueous character of extracts. This result is not consistent with those of Njoya *et al*. (2016); Rashid and Takur (2012) and Manjula *et al.* (2011) who obtained a reduction of yoghurt pH by addition of pineapple, honey and sapota respectively and this may be due to the fermentable sugars and organic acids present in these products. Moreover, results of Yousef *et al.* (2013) and Ayar and Gürlin (2014) indicated that the yoghurt pH is also influenced by the pH (degree of acidity) of the ingredient or additive used. The pH values obtained were similar to the normal pH value of yoghurt which is between 4.0 and 4.1 and in accordance with the standardof≤4.6 (FDA, 2009). They are similar to results obtained by Güler and Park (2011) and Ponka *et al.* (2013) that did their studies on popular Turkish yoghurt and artisanal Cameroonian yoghurts respectively. However, they are higher than the values proposed by Njoya *et al*. (2016) and Joseph and Joy (2011) that worked on pineapple flavoured yoghurt and yoghurt present on the Nigerian market respectively and, lower than the values of Isam *et al.* (2011) and Yousef *et al.* (2013) who respectively studied the yoghurt from fresh milk (Cow and camel) and fruit flavoured yoghurt. Generally, the pH of the yoghurt depends on many factors including the milk composition, the ingredients used and the activity of lactic acid bacteria. Titratable acidity of yoghurt samples seemed to reduce with increase in ginger extract concentration.

All yoghurt samples spiced with 15% of ginger extract presented a lower (P<0.05) titratable acidity compare to the unspiced yoghurt (control sample) while spiced yoghurt containing 5% of ginger extract except sample O (yoghurt sample containing with 5% of extract 5) were similar (P>0.05) to the control yoghurt sample. The reduction of titratable acidity of yoghurt with the increase of ginger extract concentration could be due to the dilution effect. This tendency was contrary to those observed by Njoya *et al*. (2016), Yousef *et al.* (2013), Rashid and Takur (2012) and Manjula *et al.* (2011).These authors rather obtained increasing of titratable acidity with addition of fruits or honey to yoghurt. Fruits or honey are fermentable sugars sources which serve as substrate to lactic acid bacteria with production of lactic acid in addition to their organic acids components leading to an increase of titratable acidity. The titratable acidity values observed were in accordance with the normal value (0.9 – 1%) of yoghurt and the values proposed by USDA (2001), FDA (2009) and Turkish legislation (Tarakçi and Küçüköner, 2003). They could be higher than results proposed by Njoya *et al*. (2016) and Joseph and Joy (2011), lower than those of Güler and Park (2011) and similar to those of Elfaki and AbbElrazig (2010) who studied on yoghurt samples from Sudan and Yousef *et al.* (2013). The titratable acidity of yoghurt depends mostly on the activity of lactic acid bacteria which fermented sugars into lactic acid. Thus, it depends of the availability of nutrients (especially fermentable sugars) and water activity.

The unspiced yoghurt showed the highest (P<0.05) dry matter content amongst all the yoghurt samples studied. The increase of ginger extract led to a reduction of yoghurt dry matter and this could be related to the high water content of ginger extract and the dilution effect. This result is in agreement with that of Salwa *et al.* (2004) who carried out their studies on yoghurt produced by addition of carrot juice. Nevertheless, it was not consistent with those of Njoya *et al.* (2016), Joseph and Joy (2011), Rashid and Takur (2012) and Yousef *et al.* (2013). Those authors rather used additives (Fruits and honey) in semi - solid form with relative high dry matter which lead to the increase of dry matter content of the yoghurt. Dry matter values obtained were close to those of Njoya *et al.* (2016), Ponka *et al.* (2013) and Joseph *et al*. (2011); lower than values proposed by Rashid and Takur (2012) and higher than results of Elfaki and AbbElrazig (2010), Gûler and Park (2011) and Isam *et al.* (2011). Generally, the yoghurt dry matter content is due to many factors including the milk composition as well as the quantity and the nature of ingredients used.

The unspiced yoghurt sample presented the highest value of ash content and, these value was comparable (P>0.05) to those of yoghurt spiced with 5% of extracts 4 and 6 (Samples L and R). Moreover, yoghurt ash content was reducing generally with increasing of ginger extract and it could be due to the low ash content of the ginger extract and dilution factor. Previous studies revealed an increase of yoghurt ash content with additives containing relatively high ash content and in regard of the quantity added (Yousef *et al.*, 2013). The values obtained were similar to those of Elfaki and AbbElrazig (2010), Yousef *et al.* (2013), Ponka *et al.* (2013) and Njoya *et al.* (2016) while findings of Güler and Park (2011) indicated lower values. The yoghurt ash content depends on many factors including the milk composition, the quantity and the nature of the ingredients used. Theunspiced yoghurt sample showed the highest (P<0.05) fat content. Moreover, the fat content was reducing with increasing of ginger extract concentration in yoghurt. This reduction in fat content could be explained by the low or neglected level of fat content of the aqueous extract of ginger and it is in accordance with previous findings (Njoya *et al.*, 2016; De Silva and Rathnayaka, 2014; Yousef *et al.*, 2013; Rashid and Takur, 2012; Salwa *et al.*, 2004). From those findings, use of additives (fruits and honey) with low fat content during yoghurt manufacturing resulted to a reduction of yoghurt fat content. The yoghurt fat content observed were corroborated with results of Güler and Park (2011) and seemed to be higher than values proposed by Salwa *et al.* (2004), Yousef *et al.* (2013), Ponka *et al.* (2013) and Njoya *et al.* (2016). The fat content of yoghurt generally depends of the milk composition (Fat content) on one hand and, on the other hand to the composition (fat content) and proportion of additives used.

The Non –Fat Solid (NFS) of the unspicedyoghurt was the highest (P≤0.05) amongst all the yoghurt samples. Increasing the ginger extract concentration led to reduce the NFS content of yoghurt and could be related to the low or negligible level of SNF of the extracts and the dilution effect. Manjula *et al.* (2012) and Njoya *et al*. (2016) observed similar result by using fruits with low fat content and consequently high NFS content, though De Silva and Rathnayaka (2014) on its one part, did not observed significant differences in NFS content between fruit spiced and plain yoghurt. The values obtained are ≥8.5% as recommended by American standards (FDA, 2009). They are similar to results of previous studies (Joseph and Joy, 2011;

Njoya *et al.*, 2016), lower than results obtained by De Silva and Rathnayaka (2014) and higher than values of Manjula *et al.* (2012). The NFS of yoghurt is related to milk composition and the fat content of the ingredient and the quantity used. The differences on physicochemical composition observed between the results of the present studies and previous ones could be due to the fact that physicochemical properties of yoghurt depend on many factors including milk composition, technology, nature and composition of additives; strains and activity of lactic acid bacteria.

Table 1. Physicochemical composition of fresh cow milk

(%)							
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

TA: Titratable Acidity (%lactic acid); DM: Dry Matter; NFS: Non - Fat Solid

Table 2. Yoghurt samples

Ginger extract	Extract concentration (%)	Yoghurt sample	Ginger extract	Extract concentration (%)	Yoghurt sample
/	0	unspiced	Extract 4	15	J
Extract 1	15	A		10	K
	10	B		5	L
	5	C	Extract 5	15	M
Extract 2	15	D		10	N
	10	E		5	O
	5	F	Extract 6	15	P
Extract 3	15	G		10	Q
	10	H		5	R
	5	I	/	/	/

Table 3. Physicochemical composition of yoghurt samples

Yoghurt samples	pH	TA (%)	DM (%)	Ash (%)	Fat (%)	SNF (%)
Control	4.18±0.13^{a}	1.01±0.06^{abc}	18.72±0.37^{a}	0.68±0.01^{a}	4.76±0.08^{a}	13.96±0.37^{a}
A	4.14±0.13^{a}	0.92±0.05^{efgh}	16.48±0.43^{ghi}	0.54±0.04^{g}	4.08±0.14^{hi}	12.4±0.46^{efg}
B	4.16±0.15^{a}	0.91±0.02^{fgh}	16.84±0.25^{fghi}	0.59±0.02^{def}	4.24±0.20^{efgh}	12.6±0.36^{defg}
C	4.12±0.08^{a}	0.98±0.05^{abcde}	17.9±0.63^{b}	0.62±0.02^{bcd}	4.52±0.15^{b}	13.36±0.62^{b}
D	4.10±0.12^{a}	0.90±0.03^{gh}	16.34±0.28^{hi}	0.57±0.03^{efg}	4.06±0.26^{i}	12.28±0.35^{efg}
E	4.10±0.07^{a}	0.94±0.05^{defgh}	17.0±0.44^{efg}	0.58±0.03^{def}	4.28±0.15^{defg}	12.72±0.39^{cdef}
F	4.12±0.08^{a}	0.95±0.04^{cdefg}	17.52±0.55^{bcde}	0.62±0.01^{bcd}	4.4±0.07^{bcde}	13.12±0.61^{cbd}
G	4.16±0.15^{a}	0.92±0.03^{fgh}	16.3±0.39^{hi}	0.57±0.06^{efg}	4.12±0.08^{ghi}	12.18±0.40^{fg}
H	4.14±0.08^{a}	0.96±0.05^{bcdefg}	17.1±0.37^{def}	0.60±0.03^{def}	4.36±0.11^{cdef}	12.74±0.39^{cdef}
I	4.14±0.08^{a}	1.0±0.06^{abcd}	17.8±0.21^{bc}	0.62±0.02^{bcd}	4.5±0.12^{bc}	13.3±0.14^{bc}
J	4.14±0.08^{a}	0.91±0.04^{fgh}	16.28±0.94^{i}	0.56±0.04^{fg}	4.2±0.07^{fghi}	12.08±0.88^{g}
K	4.12±0.08^{a}	0.96±0.06^{bcdef}	17.2±0.29^{def}	0.60±0.04^{cdef}	4.36±0.19^{cdef}	12.84±0.42^{bcde}
L	4.12±0.08^{a}	0.95±0.05^{cdef}	17.98±0.26^{b}	0.64±0.03^{ab}	4.56±0.05 ^{b}	13.42±0.25^{ba}
M	4.2±0.12 ^{a}	0.91±0.04^{fgh}	16.86±0.33^{fgh}	0.57±0.04^{efg}	4.14±0.13^{ghi}	12.72±0.30^{cdef}
N	4.14±0.08^{a}	0.94±0.02^{defgh}	17.24±0.43^{cdef}	0.60±0.02^{cde}	4.18±0.08^{ghi}	13.06±0.43^{bcd}
O	4.16±0.11^{a}	0.93±0.04^{efgh}	17.62±0.40^{bcd}	0.63±0.01^{bc}	4.44±0.19^{bcd}	13.18±0.39^{bcd}
P	4.2±0.12^{a}	0.89±0.04^{h}	16.48±0.36^{ghi}	0.59±0.01^{def}	4.08±0.14^{hi}	12.4±0.45^{efg}
Q	4.18±0.14^{a}	0.90±0.03^{gh}	17.1±0.39^{def}	0.61±0.03^{bcde}	4.26±0.15^{efg}	12.84±0.49^{bcde}
R	4.16±0.11^{a}	0.97±0.03^{bcdef}	17.58±0.75^{bcd}	0.65±0.03^{ab}	4.36±0.11^{cdef}	13.22±0.75^{bc}

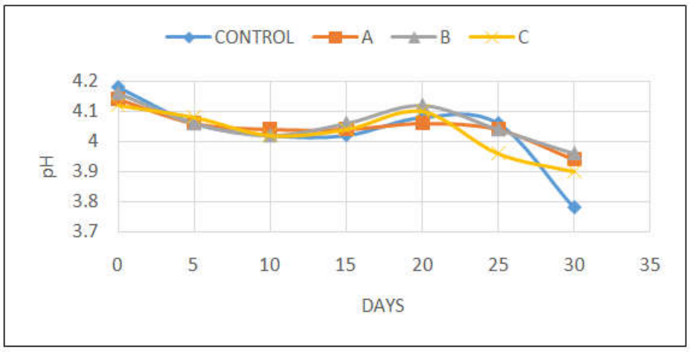
(^{a,b,c}): The values with the same superscript letter in the same column are not significantly different (P>0.05).
TA: Titratable Acidity (%lactic acid); DM: Dry Matter; SNF: Non - Fat Solid

Table 4. Sensory evaluation scores of yoghurt samples

Yoghurtsamples	Colour	Odour	Taste	Texture	Overall acceptability
Control	4.00±0.81^{abcd}	3.61±1.04^{abcd}	3.82±0.90^{ab}	3.64±0.94^{abc}	3.76±0.95^{abcd}
A	3.35±1.15^{efg}	3.55±1.07^{abcd}	3.00±1.07^{ghi}	2.82±0.90^{h}	3.23±0.88^{ef}
B	3.64±0.88^{cdef}	3.29±0.93^{cde}	3.36±0.89^{cdefgh}	3.14±0.74^{efgh}	3.38±0.69^{def}
C	3.91±0.75^{abcd}	3.55±1.10^{abcd}	3.64±0.84^{abc}	3.35±0.88^{cdefg}	3.58±0.58^{bcde}
D	3.61±0.81^{cdef}	3.38±0.92^{bcde}	3.20±1.12^{defghi}	3.14±0.82^{efgh}	3.35±0.77^{ef}
E	3.73±0.79^{cde}	3.55±0.92^{abcd}	3.29±1.11^{cdefghi}	3.29±0.71^{defgh}	3.35±0.88^{ef}
F	3.76±0.92^{bcde}	3.67±1.03^{abc}	3.82±0.83^{ab}	3.61±0.92^{abcd}	3.88±0.84^{abc}
G	3.41±0.748^{efg}	3.20±1.06^{de}	2.94±0.98^{hi}	3.05±0.88^{fgh}	3.11±0.87^{f}
H	4.02±0.79^{abc}	3.76±0.92^{ab}	3.61±0,77^{abcd}	3.73±0.70^{abc}	3.85±0.78^{abc}
I	4.26±0.70^{a}	3.67±0.84^{abc}	3,82±0.90^{ab}	3.94±0.85^{a}	3.94±0.63^{ab}
J	2.85±0.98^{hi}	3.00 ±0.69^{e}	3.08±0.75^{fghi}	2.97±0.86^{gh}	3.20±0.80^{ef}
K	3.11±0.97^{ghi}	3.23±0.85^{de}	3.20±0.80^{defghi}	3.11±0.84^{fgh}	3.26±0.82^{ef}
L	3.94±0.77^{abcd}	3.52±0.78^{abcd}	3.58±0.85^{abcde}	3.61±0.65^{abcd}	3.91±0.71^{abc}
M	2.79±0.94^{i}	3.23±0.95^{de}	2.91±0.90^{i}	3.17±0.86^{efgh}	3.05±0.77^{fg}
N	3.23±0.98^{fgh}	3.38±0.85^{bcde}	3.38±0.88^{cdefg}	3.38±0.77^{cdef}	3.35±0.81^{ef}
O	3.58±0.89^{def}	3.32±0.87^{cde}	3.55±0.89^{abcde}	3.52±0.78^{bcde}	3.52±0.82^{cde}
P	3.38±0.73^{efg}	3.32±0.68^{cde}	3.17±0.67^{efghi}	3.35±0.73^{cdefg}	3.20±0.6837^{ef}
Q	3.47±0.99^{efg}	3.32±1.06^{cde}	3.44±0.82^{bcdef}	3.41±0.74^{cdef}	3.55±0.92^{bcde}
R	4.17±0.71^{ab}	3.82±0.71^{a}	3.94±0.81^{a}	3.88±0.68^{ab}	4.11±0.76^{a}

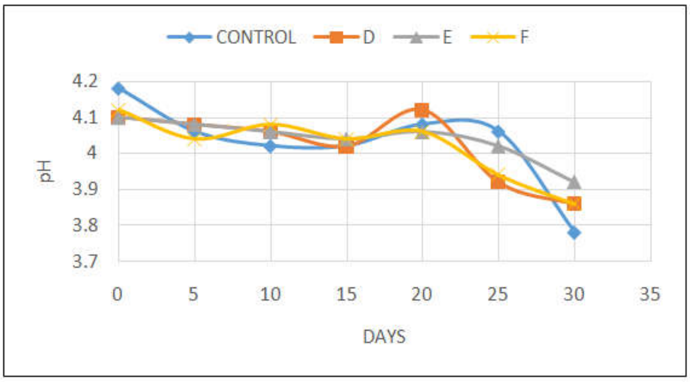
(a,b,c, …) : Les valeurs affectées des mêmes lettres sur une même colonne ne sont pas significativement différentes (P>0.05)

pH of ginger spiced yoghurt during 30 day of storage: Figures 1a to 1f show the changes of pH of yoghurt samples observed during 30 days of storage. The pH of the yoghurt samples both spiced and unspiceddid not indicate any significant (P>0.05) changes during storage except for the yoghurt spiced with 15% of ginger extract 3 (Figure 1c), yoghurt spiced with 5% of ginger extract 5 (Figure 1e) and yoghurt spiced with 15% of ginger extract 6 (Figure 1f) where during the last period (Days 25 – 30) of storage significant changes were observed.



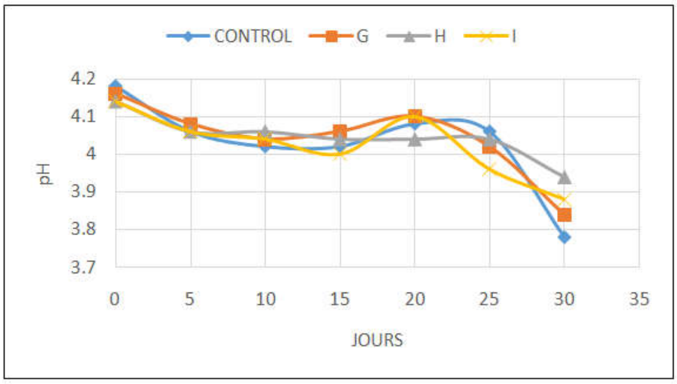
Control: Unspiced yoghurt
A: Yoghurt spiced with 15% of extract 1
B: Yoghurt spiced with 10% of extract 1
C: Yoghurt spiced with 5% of extract 1

Figure 1a. Changes in pH levels of yoghurt spiced with extract 1 during 30days of storage



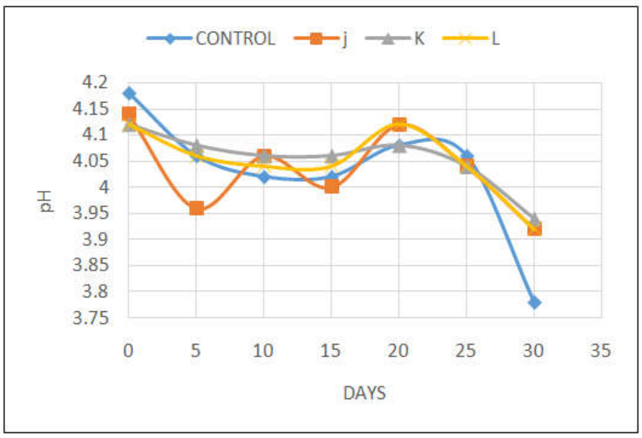
Control: Unspiced yoghurt
D: Yoghurt spiced with 15% of extract 2
E: Yoghurt spiced with 10% of extract 2
F: Yoghurt spiced with 5% of extract 2

Figure 1b. Changes in pH levels of yoghurt spiced with extract 2 during 30days of storage



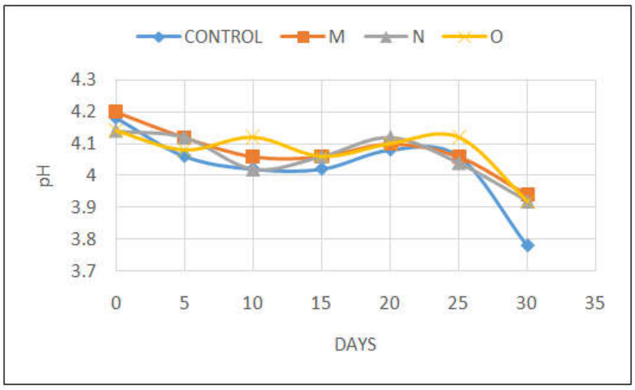
Control: Unspiced yoghurt
G: Yoghurt spiced with 15% of extract 3
H: Yoghurt spiced with 10% of extract 3
I: Yoghurt spiced with 5% of extract 3

Figure 1c. Changes in pH levels of yoghurt spiced with extract 3 during 30days of storage



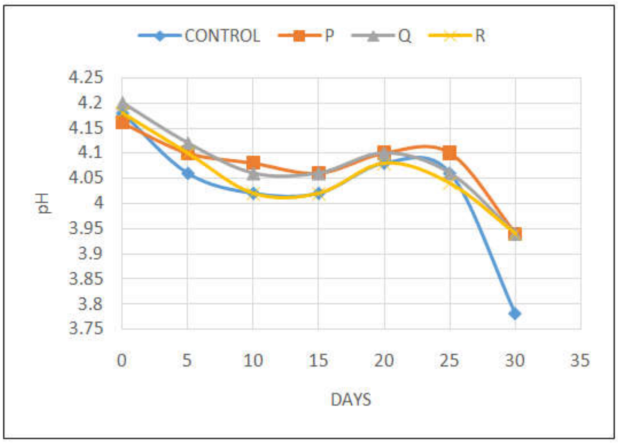
Control: Unspiced yoghurt
J: Yoghurt spiced with 15% of extract 4**K**: Yoghurt spiced with 10% of extract 4**L**: Yoghurt spiced with 5% of extract 4

Figure 1d. Changes in pH levels of yoghurt spiced with extract 4 during 30days of storage



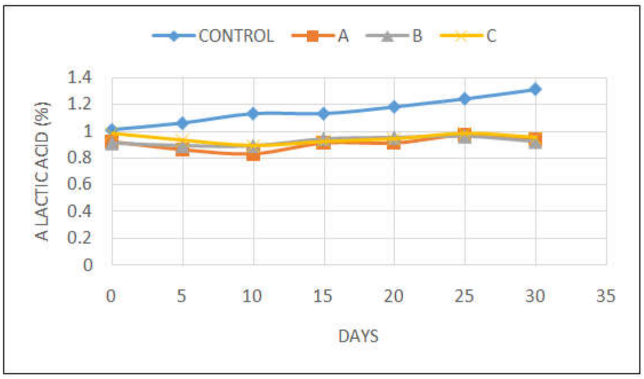
Control: Unspiced yoghurt
M: Yoghurt spiced with 15% of extract 5**N**: Yoghurt spiced with 10% of extract 5**O**: Yoghurt spiced with 5% of extract 5

Figure 1e. Changes in pH levels of yoghurt spiced with extract 5 during 30days of storage



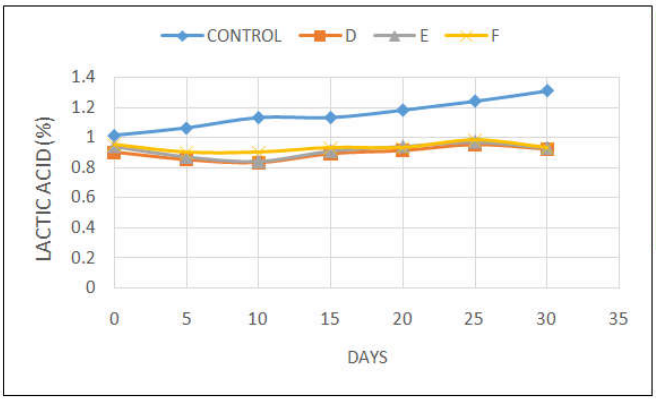
Control: Unspiced yoghurt
P: Yoghurt spiced with 15% of extract 6**Q**: Yoghurt spiced with 10% of extract 6**R**: Yoghurt spiced with 5% of extract 6

Figure 1f. Changes in pH levels of yoghurt spiced with extract 5 during 30days of storage



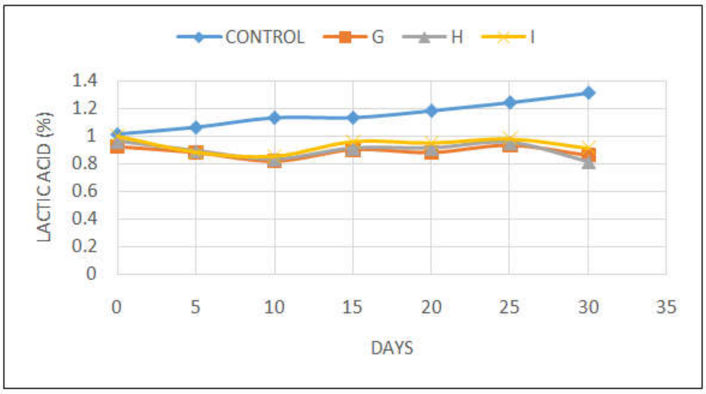
Control: Unspiced yoghurt
A: Yoghurt spiced with 15% of extract 1
B: Yoghurt spiced with 10% of extract 1
C: Yoghurt spiced with 5% of extract 1

Figure 2a. Changes in lactic acid levels of yoghurt spiced with extract 1 during 30days of storage



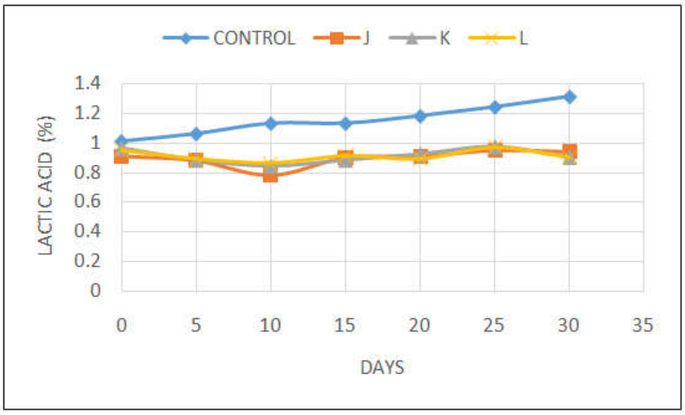
Control: Unspiced yoghurt
D: Yoghurt spiced with 15% of extract 2
E: Yoghurt spiced with 10% of extract 2
F: Yoghurt spiced with 5% of extract 2

Figure 2b. Changes in lactic acid levels of yoghurt spiced with extract 2 during 30days of storage



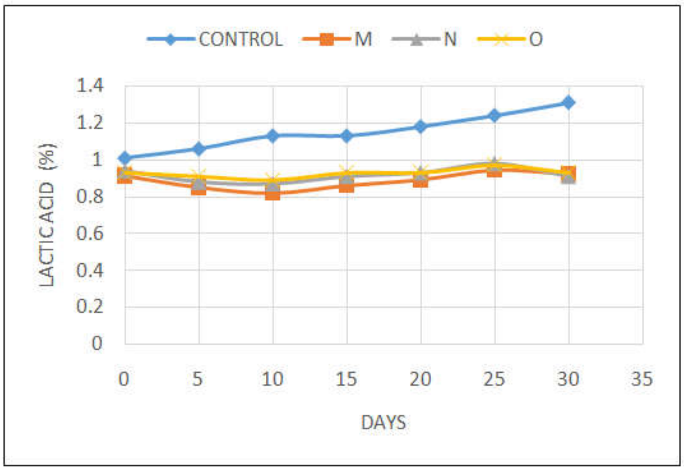
Control: Unspiced yoghurt
G: Yoghurt spiced with 15% of extract 3
H: Yoghurt spiced with 10% of extract 3
I: Yoghurt spiced with 5% of extract 3

Figure 2c. Changes in lactic acid levels of yoghurt spiced with extract 3 during 30days of storage



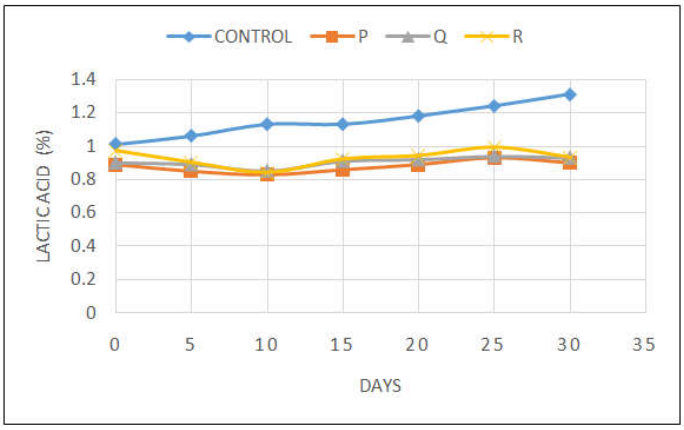
Control: Unspiced yoghurt
J: Yoghurt spiced with 15% of extract 4
K: Yoghurt spiced with 10% of extract 4
L: Yoghurt spiced with 5% of extract 4

Figure 2d. Changes in lactic acid levels of yoghurt spiced with extract 4 during 30days of storage



Control: Unspiced yoghurt
M: Yoghurt spiced with 15% of extract 5**N**: Yoghurt spiced with 10% of extract 5**O**: Yoghurt spiced with 5% of extract 5

Figure 2e. Changes in lactic acid levels of yoghurt spiced with extract 5 during 30days of storage



Control: Unspiced yoghurt
P: Yoghurt spiced with 15% of extract 6
Q: Yoghurt spiced with 10% of extract 6
R: Yoghurt spiced with 5% of extract 6

Figure 2f. Changes in lactic acid levels of yoghurt spiced with extract 6 during 30days of storage

The pH value was unchanged till day 25 of storage and this may be related to the low activity of lactic acid bacteria. This insignificant change observed during pH evolution of all the yoghurt samples during storage is in accordance with results of Duangrutai (2014) who used thai fruits (pineapple, pawpaw and mango) to flavour yoghurt and stored for 21 days but not with that of Tarakçi and Küçüköner (2003), Salwa*et al.* (2004), Elfaki and AbbElrazig (2010), Isam*et al.* (2011), Manjula*et al.* (2012), Yousef *et al.* (2013), Ayar and Gürlin (2014) and Njoya *et al.* (2016) who observed reduction of yoghurt pH from the beginning of storage till 15 days of storage. Moreover, a significant decline (P<0.05) of pH between the initial and the final values of all the yoghurt samples was observed. The significant difference between the final and the initial values of pH of all the yoghurt samples during storage was expected and could be related to the continuous fermentation of lactose into lactic acid during storage at refrigerated conditions. During storage at refrigerated conditions, activity of lactic acid bacteria is not completely stopped and there is production of lactic acid leading to a drop of pH. At the end of storage, the unspiced yoghurt samples indicated the lowest (P<0.05) pH value while all the spiced yoghurt samples presented a comparable (P>0.05) pH values. This could indicate the low level of fermentation in spiced yoghurt samples due to the antimicrobial activity of ginger extract. Ginger could thus contribute for the preservation of yoghurt.

Titratable acidity of ginger spiced yoghurt during 30 day of storage: The changes in titratable acidity of the yoghurt samples are presented in Figures 2a – 2f. The unspiced yoghurt (control yoghurt sample) showed the highest (P<0.05) titratable acidity amongst all the yoghurt samples. Moreover, it indicated an increase of titratable acidity during storage except from day 10 to day 15 while all the other experimental yoghurt samples (spiced yoghurt samples) did not present significant (P>0.05) changes. Also, only the unspiced yoghurt sample indicated a significant difference (P≤0.05) between the final and the initial values during storage. At the end of storage, the highest (P≤0.05) titratable acidity was observed with the unspiced yoghurt sample and all the spiced yoghurt obtained the comparable (P>0.05) values. The increase of titratableacidity observed with the unspiced yoghurt sample was expected due to the action of lactic acid bacteria at storage conditions (4- 6°C) with production of lactic acid. This result is in conformity with previous findings (Tarakçi and Küçüköner, 2003; Salwa *et al.* 2004; Elfaki and AbbElrazig, 2010; Isam *et al.*, 2011; Manjula *et al.*, 2012; Yousef *et al.*, 2013; Ayar and Gürlin, 2014 and Njoya *et al.*, 2016). The unchanged values of titratable acidity observed during storage with spiced yoghurt samples could be explained by the inhibition of lactic acid bacteria activity (growth) due to the antimicrobial activity of ginger. The high acidity obtained with control yoghurt sample compare to experimental yoghurt samples at the end of storage could express a positive effect of ginger extract on the yoghurt preservation.

Sensory evaluation: The results of sensory evaluation presented in table 4 revealed that yoghurt sample I (Spiced yoghurt with 5% of extract 3) obtained the high score in term of colour. This value was not significant (P>0.05) different from those of control yoghurt (Unspiced yoghurt) sample and yoghurt samples C (Spiced yoghurt with 5% of extract 1), H (Spiced yoghurt with 10% of extract 3), L (Spiced yoghurt with 5% of extract 4) and R (Spiced yoghurt with 5% of extract 6). Appreciation of the yoghurt colour with spiced yoghurt samples having 15% of ginger extract was low except sample D (Spiced yoghurt with 15% of extract 2). Thus, increasing the concentration of ginger extract in yoghurt lowered its appreciation by panellists. This could be due to the brownish coloration of the extract which modified the original colour of yoghurt. According to the panellists, all spiced yoghurt samples showed similar (P>0.05) mean scores with the unspiced (control) yoghurt sample except for sample J (Spiced yoghurt with 15% of extract 4) which presented a lower mean score for odour. The taste of all the spiced yoghurt samples made with 5% of ginger extract was not significantly (P>0.05) different from each other and with that of the control though sample R (Spiced yoghurt with 5% of extract 6) obtained the high mean score. The increase in the concentration of extract in yoghurt led to reduction of the appreciation of the taste of yoghurt. Ginger is characterized by its pungent taste thus at high concentration, it could be highly expressed by reducing the taste of the spiced yoghurt. The texture of the control yoghurt sample was similar (P>0.05) to those of the spiced yoghurt with 5% of extract and different (P≤0.05) from those of the spiced yoghurt samples containing 15% of extract except sample P (Spiced yoghurt with 15% of extract 6). The quality of yoghurt texture decreased with increasing of the ginger extract concentration. The liquid form of the ginger could reduce the firmness of yoghurt and subsequently its texture by dilution. At lower proportion of extract, the dilution effect is low and could justify the similarity of texture between unspiced yoghurt and spiced yoghurts with 5% of ginger extract. Yoghurt sample R (Spiced yoghurt with 5% of extract 6) presented mean score of overall acceptability which was not different (P>0.05) from those of yoghurt samples F, I and L respectively prepared with 5% of extract 2, 3 and 4. All the spiced yoghurt made with 5% of ginger extract showed the same level (P>0.05) of overall acceptability with the unspiced yoghurt sample which was not the case with yoghurt samples spiced with 15% of extract. The overall acceptability of yoghurt was generally reduced with increasing ginger extract concentration. At high concentrations, ginger sensory properties could be express strongly. Therefore, it affects the original sensory properties of yoghurt by lowering its appreciation.

Conclusion

Ginger extract incorporated to yoghurt have no effect on pH of yoghurt but decrease its titratable acidity, dry matter, fat, SNF and ash content and especially at high concentrations (10 and 15% (V/V)). During storage, they positively affect the change of pH and titratable acidity. Ginger extract, at 5% has no effect on the sensory properties of yoghurt and its overall acceptability and increasing its concentration lowers those properties.

REFERENCES

Abd El – Aziz, M., Mohamed, S.H.S., Seleet, F.L. and Abd El – Gawad, M.A.M. 2015. Effect of brine solution containing ginger extracts on the properties of Egyptian white brined cheese,*American Journal of Food Technology*, Vol.101, pp37-47.

Adesokan, I.A., Abiola, O.P. and Ogundiya, M.O. 2010. Influence of ginger on sensory properties and shelf-life of Ogi, a Nigerian traditional fermented food,*African journal of biotechnology*, Vol. 9, pp1803 – 180.

Ahmed, R. and Sharma, S. 1997. Biochemical studies on combined effect of garlic Allium sativum Linn and ginger *Zingiberofficinale*Rosc in albino rats,*Indian journal of Experimental Biology*, Vol. 35, pp841-843.

Akoachere, J.F., Ndip, R.N. and Chenwi, E.B. 2002. Antibacterial effect of Zingiberofficinale and Garcinia kola on respiratory tract pathogens, *East Afr Med J.,*Vol. 7911, pp588-592.

Al – Amin, Z.M., Thomson, M., Al-Qattan, K.K., Peltonen-Shalaby, R. and Ali, M. 2006. Anti-diabetic and hypolipidaemic properties of ginger *Zingiberofficinale* in streptozotocin-induced diabetic rats, *British Journal of Nutrition,* Vol. 964, pp660-666.

AOAC, 1990. Official methods of analysis. 15th ed Washington DC. Edr., Washington DC.

Aruoma, O.I., Spencer, J.P., Warren, D., Jenner, P., Butler, J. and Halliwell, B.1997. Characterization of food antioxydants illustration using commercial garlic and ginger preparation,*Food chemistry*, Vol. 60, pp49 – 156.

Aswal P., Shukla A. and Priyadarshi S. 2012.Yoghurt: preparation, characteristics and recent advancements,*Cibtech Journal of Bio-Protocols,* Vol. 12, pp32-44.

Atai, Z., Atapour, M. and Mohseni, M. 2009. Inhibitory Effect of Ginger Extract on *Candida albicans*. *American Journal of Applied Sciences,* Vol.66, Pp1067-1069.

Ayar, A. and Gürlin, E. 2014. Production and Sensory, Textural, Physicochemical Properties of Flavored Spreadable Yogurt,*Life Science Journal,* Vol. 114, 8p

Belewu, M.A., Belewu, K.Y and Bamidele, R.A. 2010.Cyper-coconut yoghurt: preparation, compositional and organoleptic qualities,*African Journal of Food Science and Technology*, Vol. 11, pp10-12.

Bhandari, U., Kanojia, R. and Pillai, K. K. 2005. Effect of ethanolic extract of *Zingiberofficinale* on dyslipidaemia in diabetic rats. *Journal of Ethnopharmacology,*Vol. 972, Pp227-230.

Buttris, J. 1997. Nutritional propertiesof fermented milk products,*International journal of dairy technology*, Vol. 50,pp21– 27.

De Silva, K.L.S.R. and Rathnayaka, M.U.S.K. 2014. Physico-chemical Sensory and Microbiological Evaluation of Set and Fruit Yoghurt in Sabaragamuwa Province, Sri Lanka, *Journal of Scientific Research & Reports*, Vol. 32, pp284-293.

Duangrutai, T. 2014. Effect of Thai fruits on Sensory Properties of Fruit Yogurt and Survival of Yogurt Starter Culture added with Probiotic Strains in Fruit Yogurt,*Res. J. Pharm. Biol. Chem. Sci.,* Vol. 53, pp283-290.

Elfaki, E.A. and AbbElrazig, E.B. 2010. Quality assurance of different types of yoghurt in Khartoum state markets.Gezira, *J. of eng& applied Sci*.Vol52, pp1–16.

FDA, 2009. Milk and cream products and yogurts products. Food and Drugs Administration. Federal register, 74.

Gugnani, H.C. and Ezenwanze, E.C. 1985. Antibacterial activity of extracts of ginger Zingiberofficinale and African oil bean seed Pentaclethoramacrophylla,*J Commun Dis*. Vol. 17, P233.

Güler, Z. and Park, Y.W. 2011. Characteristics of physico – chemical properties, volatile compounds and free fatty acid profiles of commercial set – type Turkish yoghurts,*Journal of Animal Sciences*, Vol. 11, pp1–9.

Guyer, D. 2003. Advanced medical centre Zionsville, Indiana, Indianapolis, USA. http://www;daleguyermd.com/glosary /ginger. htlm website accessed on 26 june 2009.

Heyman, M. 2000. Effect of lactid acid bacteria on diarrheal diseases, *J. Am. Coll. Nutr*., Vol. 19:137- 146.

ICMR, 2003. Ginger: its role in xenobiotic metabolism. *ICMR Bulletin*, June 2003, Vol. 33 6, Pp 57 – 63.

Isam, A.M.A.O., Eshraga, A.E., Abu Elgasim, A.Y. and Efadil, E.B. 2011. Physicochemical, microbiological and sensorycharacteristics of yoghurt produced from camel milkduring storage,*Electronic Journal of Environmental, Agricultural and Food ChemistryEJEAChe.,*Vol. 106, pp2305–2313.

Joseph, A.O. O. and Joy, E.O. 2011. Physico – chemical and sensory evaluation of market yoghurt in Nigeria,*Pakistan Journal of Nutrition*, Vol. 1010, pp 914–918.

Kaushik, P. and Goyal, P. 2011. Evaluation of Various Crude Extracts of *Zingiberofficinale*Rhizome for Potential Antibacterial Activity: A Study *in Vitro,Advances in Microbiology,* Vol. 1, pp7-12.

Latona, D.F., Oyeleke, G.O. and Olayiwola, O.A. 2012. Chemical analysis of ginger root,*ISSR journal of applied chemistry*, Vol. 11, p47–49.

Lee, W.J. and Lucey, J.A. 2010. Formation and Physical Properties of Yoghurt,*Asian-Australian Journal of Animal Science,* Vol. 239, pp1127 – 1130.

Madhu, A.N., Amrutha, N., Prapulla, S.G. 2012. Characterization and antioxidant property of probiotic and symbiotic yoghurts. *Probiotic and protein*, Vol. 14, pp90–97.

Manjula, K., Viswanath, C. and Suneetha, C. 2012. Physico-Chemical, Sensory and Microbial Quality of Yoghurt Fortified with Sapota Pulp,*International Journal of Material Sciences and Chemistry,* Vol. 11, pp4 – 6.

Marona, D. and Pedrigon, G. 2004. Yoghurt feeding inhibits promotion and progression of cancer, *Med. Sci. Monit*., Vol. 10, pp96-104.

Mendi, S. D. 2011. Developpement of bambirad a ginger - spiced cheese as a functional food. PhD thesis, ENSAI – The University of Ngaoundere, Cameroon.

Njoya, M.A., Mahbou, P.Y., Nain, C.W. and Imele, H. 2016. Physicochemical, microbiological and sensory properties of pineapple *Ananascomosus* L. Merr. flavoured yoghurt,*International Journal of Agriculture Innovations and Research*,Vol. 46, pp1154 – 1158.

Olubunmi, B.A., Seun, F.A. and Funmilayo, T.A. 2013. Food value of two varieties of ginger *zingiberofficinale* commonly consumed in Nigeria,*Hindawipublishing corporation. ISRN Nutrtition,* 5p.

Perdigeon,G., Valdez, J. and Rachid, M. 1998. Antitumour activity of yoghurt. Study of possible immune response,*J. Dairy Res*., Vol. 65, pp129-138.

Ponka, R., Beaucher, E., Fokou, E., Kansci, G., Piot m.,Lleonil, J. and Gaucheron, F. 2013. Composition of raw cow milk and artisanal yoghurt collected in Maroua Cameroon,*African Journal of Biotechnology*, Vol. 1249, pp6866 – 6875.

Rashid, A. and Thakur, E.S.N. 2012. Studies on Quality Parameters of Set Yoghurt Prepared By the Addition of Honey,*International Journal of Scientific and Research Publications*, Vol. 9, pp1–9.

Salwa, A., Galal, E.A. and Neimat, A.E. 2004. Carrot Yoghurt: Sensory, Chemical, Microbiological Properties and Consumer Acceptance, *Pakistan Journal of Nutrition*, Vol. 36, pp322-330.

Tamine A.Y. and Deeth H.C. 1980. Yoghurt, technology and biochemistry,*Journal of Food. Protection*, Vol. 4312, pp937–977.

Tarakçi, Z. and Küçüköner, E. 2003. Physical, Chemical, Microbiological and Sensory Characteristics of Some Fruit-Flavored Yoghurt,*YYÜ Vet FakDerg*.,Vol. 142, pp10-14.

Thomson, M., Al Qattan, K.K. and Al Sawan, S.M. 2002. The use of gingerZingiberofficinale Roscoe as a potential antiflammatory and antithrombotic agent,*Prostaglandins LeukotEssent Fatty Acids*, Vol. 676, pp475-478.

USDA, 2001. Specifications for Yogurt, Non Fat Yogurt and Low Fat Yogurt. Document 21 CFR, part 131, pp200- 203.

Yousef, M., Nateghi, L. and Azadi, E. 2013. Effect of different concentration of fruit additives on some physicochemical properties of yoghurt during storage,*Ann. Biol. Res.*, Vol. 44, pp244-249.

****