

Nutrient Composition of Commercially Available Yogurts in Abeokuta

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Abstract

Yogurt is considered to be a nutrient-dense food that significantly contributes to the intake of several nutrients, including micronutrients and macronutrients. Micronutrient deficiency, which has been considered as a major risk factor in child survival in Nigeria, increases the risk of death from common diseases such as acute gastroenteritis, pneumonia and measles. Available data on nutrient content of food consumed is crucial in dietary management of these diseases. Four commercially available yogurts in the three major markets of Abeokuta coded as Z₁, Z₂, Z₃ and Z₄ underwent analysis for proximate and micro nutritional properties using established standard methods. The obtained data were subsequently analyzed utilizing SPSS version 21. Significance was approved at p<0.05. The micronutrient analyzed yogurt samples showed that vitamin C, vitamin E, sodium, calcium, potassium, magnesium, zinc and iron content ranged from 7.23 - 15.2mg/100g, 9.81 - 13.1mg/100g, 90.8 - 85.5mg/100g, 57.2 - 112mg/100g, 54.1 - 117mg/100g, 8.62 - 14.4mg/100g, 0.14 - 0.30mg/100g and 0.75 - 0.53mg/100g respectively. The proximate composition of the analyzed yogurt samples showed that, Crude fibre, ash, moisture, fat, protein and carbohydrate content ranged from 5.15 - 4.59%, 5.38 - 5.06%, 76.42 - 70.22%, 7.96 - 9.6%, 0.97 - 1.41 and 3.12 - 9.03% respectively. These findings emphasize the substantial variability in the micronutrient composition suggesting subtle difference in their nutritional profiles, same with the variability of proximate composition which highlights the importance of considering these nutritional attributes in dietary planning and food product development. Overall, with yogurt consumption, there is better diet quality and improved metabolic profiles.

Keywords: Macronutrients, malnutrition, micronutrient, yogurt

Introduction

Nutrients are substances that must be present in the diet of individuals in order to promote growth, maintain and repair tissues, generate energy and regulate body processes when ingested and absorbed (James *et al.*, 2002) [22]. Nutritional science principally distinguishes two different classes of nutrients among its classification; macronutrients and micronutrients. Macronutrients can be considered as the main component of different tissues, and they constitute the total amount of the calorie intake, meaning the principal energy source of the human body; they are mainly distinguished in carbohydrate, protein and lipids (Carreiro, *et al.*, 2016) [11]. They are required in large amounts to maintain body functions and carry out the activities of the daily life (Whitney and Rolfes, 2019) [42]. Micronutrients is the umbrella term used to represent essential vitamins and minerals required from the diet to sustain virtually all normal cellular and molecular functions in the human body (West *et al.*, 2012) [41]. They are components of the diet that do not provide a significant contribution on the caloric intake, but can still be considered crucial for health and vital functions, even if needed in smaller amounts. They principally include vitamins (both fat-soluble and water-soluble) and minerals (macro-minerals and micro-minerals) [Shergill-Bonner, 2017] [36].

Yogurt is a nutrient-dense probiotic food, with unique properties that enhance the bioavailability of some nutrients and potentially enhancing health. Yogurt consumption has been associated with health benefits in different populations

beyond nutrient provision because it contains unique bioactive compounds and live and active cultures associated with positive health outcomes (Kok and Hutkins, 2018) [25]. It has nutritional benefits beyond those of milk. Since most of the lactose in the milk precursor has been converted to lactic acid by the bacterial culture, people who are moderately lactose intolerant can enjoy yoghurt without ill effects (Heyman, 2000; Vesa *et al.*, 2000) [21, 40]. Its consistent consumption in both children and adults has been attributed to reduced cardiometabolic and obesity risk (Marette and Picard-Deland, 2014) [30]. Yogurt is the product of milk, fermented with the lactic cultures *Streptococcus thermophiles* and *Lactobacillus delbrueckii* subsp *bulgaricus*, which can be enhanced with other probiotic cultures such as *Lactobacillus acidophilus* and *Bifidobacterium bifidus* (EPCEU, 2006) Consumption of fermented dairy products has long been considered to be beneficial to digestive and overall health (Morelli, 2014) [31]. Because of the effect of yogurt on immune regulation and its probiotic benefit, it is a justified recommendation as a healthy food for children and adults. Yogurt is a valuable source of energy, and thus is considered an important element of the human diet in many countries around the world (Williams, 2015) [47].

Malnutrition is a universal public health problem in both children and adults (WHO, 2019) [45]. It is not only a public health concern but it is an impediment to global poverty eradication, productivity and economic growth. By eliminating malnutrition, it is estimated that 32% of the

global disease burden would be removed (WHO, 2020) [26]. As a widespread serious problem affecting children in developing countries, progress towards tackling the different forms of malnutrition remains relative (GNR, 2018) [20]. Micronutrient malnutrition is affecting more than one third of the world's population and growing to be a global threat from health perspective (WHO, 2005). The full genetic potential of a child for physical growth and mental development may be compromised due to sub clinical deficiencies of micronutrients, which are commonly referred to as "hidden hunger". Children with these sub clinical deficiencies of micronutrients are more vulnerable to develop frequent and more severe common day-to-day infections thus triggering a vicious cycle of under nutrition and recurrent infections (Singh, 2004) [35]. Furthermore, micronutrient absorption in the small intestine maybe impeded due to infection, disease or inflammation (UNICEF, 2013; Katona, 2008) [24, 38]. For infants, micronutrient deficiency may result from maternal micronutrient deficiency in utero or rapid postnatal growth (Zlotkin, 2011) [50]. Protein-energy undernutrition affects particularly the pre-school children (<6years) with its dire consequences ranging from physical to cognitive growth and susceptibility to infection. This affects the child at the most crucial period of time of development which can lead to permanent impairment in later life (Gragnotati, *et al.*, 2005; Park, 2007) [19, 33].

Pregnancy is a time of rapid and profound physiological changes from the time of conception until birth. Nutritional requirement increases during pregnancy to maintain maternal metabolism and tissue accretion while supporting foetal growth and development (Baker *et al.*, 2002) [7]. Poor dietary intake or deficiencies in key macronutrients and micronutrients can therefore have a substantial impact on pregnancy outcomes and mental health. Increasing evidence suggests that the effects of foetal malnutrition may persist well into adulthood with possible intergenerational effects (Anderson, 2001) [2]. Both clinical and subclinical forms of nutrient deficiencies contribute considerably to the global disease and economic burden. Innumerable approaches have been attempted to provide solutions in this regard. A combination of programs such as promotion of breastfeeding, nutrition education and control of infectious disease alongside micronutrient intervention is essential to tackle malnutrition (Black and Walker, 2013) [8]. Key interventions to combat malnutrition at the level of populations or groups include food fortification, biofortification, use of special nutritional products, high-dose supplements and dietary diversification (World Food Programme, 2014). Childhood malnutrition continues to be the leading public health problem in developing countries. Globally, there were 165 million stunted, 99 million underweight and, 51 million wasted children by 2012. It kills 3.1 million under-five children every year (Black and Walker, 2013) [8].

Materials and method

Sample size and sampling technique

A pilot study was earlier conducted on the commercially available yogurts in the three major markets of Abeokuta (Osiele, Kuto and Lafenwa) and four most commonly consumed yogurt samples were selected. The four samples selected were based on the brand name and consideration for type of yogurt. Thereafter, three plain sweetened

yogurts, and one unsweetened one, were selected. The yogurt samples were coded as, Z₁, Z₂, Z₃ and Z₄ and kept at ambient temperature until used for analysis. The other materials for analysis were obtained in the food processing laboratory of the University of Agriculture, Abeokuta.

Proximate composition analysis

Samples were analyzed chemically according to the Official Methods of Analysis described by the Association of Official Analytical Chemistry. Analysis is carried out in triplicates.

Moisture determination

Reference: AOAC 2005 [4].

Procedure: 2g of the sample was dried in a hot air oven for 24hours at 100-C recorded as W₁. The lost in weight was determined and recorded as moisture content W₂.

Calculation: % Moisture = $\frac{W_1 - W_2}{W_1} \times 100$

Protein Content Determination

Reference: AOAC 2010a

Procedure: 1g of the sample was introduced into the digestion flask, and 7 kjedahl tablets was added to it. 20 ml. of concentrated H₂SO₄ was added and digested for 5 hours until a clear solution is obtained. The digest was cooled, then transferred into 100ml of volumetric flask and made up to the mark with distilled water. 20 ml of Boric acid was dispensed into a conical flask while 5 drops of Tashiro's indicator and 75ml of distilled water was added to it. 10ml of the digest was dispensed into Kjeldahl distillation flask. The conical flask and the distillation flask are fixed in place and 20% NaOH was added through the gas funnel into the digest. The steam exit was closed and the time for the solution of the Boric acid and the indicator turned green was noted. The distillation was carried out for 15 minutes and the distillate titrated with 0.05M HCL.

Calculation:

% Total Nitrogen = $\frac{(\text{Sample titre} - \text{blank titre}) \times 14.01 \times N}{10 \times \text{sample weight}}$

% Crude protein = % Total Nitrogen x 6.25

Where N = Acid concentration in normality unit

14.01 = Molecular weight of nitrogen

6.25 = constant factor

Crude fibre determination

Reference: AOAC 2005 [4].

Procedure: 5g of sample was weighed as W and fat was extracted with petroleum ether using soxhhlet extractor. The fibre sample was weighed into 500ml prepared sulphuric acid solution as W₁. The mixture was boiled for 30minutes, refluxed for three times by boiling water and was followed by the addition of 100mlnprepared sodium hydroxide. The beaker was heated and the boiling was allowed to continue for another 30minutes. Finally, fibre was extracted and dried by moistening with small portion of acetone which was

permitted to drain. The sample in the crucible was incinerated at 550⁰ C for 3hours until all carbonaceous matter was burnt. The crucible containing the ash was cooled in the desiccator and weighed as W₂

$$\text{Calculation: \% Crude fibre} = \frac{W_1 - W_2}{W} \times 100$$

Ash Content Determination:

Method: Direct Heating in a Muffle Furnace

Reference: AOAC 2005 [4].

Procedure: 2g each of the samples was measured into a crucible of known weight W₁, the sample was burnt to ash in a muffle furnace for 3hours at 550⁰ C. it was then cooled in a desiccator and the weight of the ash W₂ was finally determined.

$$\text{Calculation: \% Ash} = \frac{W_1 - W_2}{W_1} \times 100$$

Fat Determination

Equipment: Soxhlet Extractor

Reference: AOAC 2005 [4].

Procedure: 2g of sample was weighed into a flatbottom flask of known weight with the extractor mounted on it. The thimble was held half way into the extractor and the weighed sample was carefully transferred into the thimble and the thimble was plugged with cotton wool. The extraction was carried out at the temperature of 40-60⁰C for 8hours. The solvent was removed by evaporation and then, the remaining part of the flask was dried in the oven at 80⁰C for 30minutes and was finally cooled in a desiccator. The flask was reweighed and the percentage fat was calculated as,

$$\text{Calculation: \% fat} = \frac{\text{Weight of extracted fat}}{\text{Weight of sample used}} \times 100$$

Carbohydrate Determination

Method: Carbohydrate determination by difference.

Reference: Ihekoronye and Ngoddy 1985

$$\% \text{ carbohydrate} = 100 - (\% \text{ ash} + \% \text{ protein} + \% \text{ fat} + \% \text{ crude fibre} + \% \text{ moisture})$$

Micronutrient composition analysis

Samples were analyzed chemically according to the Official Methods of Analysis described by the Association of Official Analytical Chemistry. Analysis is carried out in triplicates.

Mineral determination

1. Calcium, Iron, Zinc and Magnesium

Reference: AOAC, 2002 [3].

Procedure: All crucibles required for mineral analysis are washed with 6N HCL and glass wares with 10% nitric acid. The required number of crucibles are placed in an oven for 30minutes at 100⁰C, cooled in a desiccator for 30 minutes and weighed W₁. 1gramme of sample was accurately weighed and subjected to chare at hot plate starting from

low temperature under a hood. The samples are ash in a muffle furnace at 475⁰C for 1 hour and the crucibles are taken out from the furnace, cooled, and moistened with a few a few drops of iodized water. The temperature was evaporated on a hot plate. The samples were ash once more for 30 minutes at 475⁰C and cooled in the crucible; some drops of deionized water and 5 drops of concentrated HNO₃ were added and evaporated on a hot plate as described above. Finally, the samples were ash as above for 30 minutes at the same temperature as previously described. The crucibles were cooled in a desiccator for 45 minutes and then weighed as W₂.

Six mil of 6N HCL was added to the ash sample to wet it completely and carefully taken to dryness on a low temperature hot plate. Seven ml of 3N HCL was added and the crucible heated on the hot plate until the solution just boils. Then the solution was cooled and filtered through a Whatman No 1 paper into a 50ml graduated flask. Five ml of 3N HCL was added to the crucibles and the solution was heated until it starts to boil, cooled and filtered into the graduated flask. The crucibles were washed at least three times with deionized water and the washing were filtered into the flask. Five ml of lanthanum chloride solution per 100ml of solution was added to the extract to free bounded calcium. The content of the flask was cooled and diluted to the volume of the flask with deionized water. The sample extract solution was transferred to polyethene bottle and stored until used for determination of minerals. Blank was prepared without sample by taking the same quantity of reagents under the same condition.

2. Sodium and potassium

Reference: AOAC, 2012 [5].

Procedure: 2ml of samples were weighed into 250ml conical and 20ml of diluted nitric acid (1:1 ratio with deionized water) was added. The mixture was digested by gently boiling on a hot plate for 10minutes. The digest was cooled and filtered into 100ml volumetric flask. The conical flask and residue left on the filter paper was washed several times with deionized water and the volumetric flask containing the filtrate was made to the mark with deionized water. 50 ml of the extract was taken from the filtrate and added into another 100ml volumetric flask for sodium analysis. 5ml of previously prepared diluted potassium chloride solution was added and the volume was filled to the mark with deionized water.

For potassium, 5 ml of the extract was added into 100ml volumetric flask and the volume was made to the mark with deionized water. Blank solution was prepared in a similar manner without addition of the sample extract. Sodium and potassium were determined from the aliquots of the sample extract. Sodium and potassium were determined from the aliquots of solutions using flame photometer.

Vitamin analysis

The vitamin in the samples were determined by the Official Methods of the Association of Official Analytical Chemist (AOAC 1990)

Vitamin C Determination:

About 0.5g of the sample was weighed, macerated with 10mls of 0.4% Oxalic acid in attest tube for 10minutes, centrifuged for 5minutes and the solution filtered. 1ml of the

filtrate was transferred into a dry test tube in duplicates, 9mls of 2,6-dichlorophenol indophenol was added and absorbance was taken at 15seconds and 30seconds interval at 520nm.

Vitamin E Determination: 1g of the original sample weighed, macerated with 20mls of n-hexane in attest tube for 10minutes and configured for 10minutes. The solution was filtered, 3mls of the filtrate was transferred into a dry test tube and evaporated to dryness in a boiling water bath. Following this, 2mls of 0.05N alcoholic potassium hydroxide was added and boiled for 30minutes in a water bath. Then 3mls of n-hexane was added and shaken vigorously. The n-hexane was transferred into another set of test tubes and evaporated to dryness. A volume, 2mls, of ethanol was added to the residue. Another volume, 1ml of 0.2% Ferric chloride in ethanol was added. Then 1ml of 0.5% $\alpha^1 \alpha^1$ - dipyridyl in ethanol was added followed by addition of 1ml of ethanol to make it up to 5mls. The solution was mixed and absorbance taken at 520nm against the blank.

Statistical analysis

The data was analyzed through one-way analysis of variance using Statistical Package for Social Science software version 21. To separate means, the Duncan Multiple Range Test was used, and statistical significance was acknowledged at a level of $p < 0.05$

Result and discussion

Micronutrient and macro-mineral composition of yogurt samples

The nutrient analysis of the yogurt samples is presented in Table-1. The samples showed notable variations in micronutrient and micromineral content. These variations are statistically significant ($p < 0.05$) indicating clear difference in micronutrient and macro content among the samples.

The vitamin content of the samples is relatively high, and this suggests fortification.

Milk does not provide sufficient amount of vitamin C, then the vitamin C content in yogurt can be easily destroyed by heat treatment during processing. According to Doseděl *et al.*, 2021 [13], fortification of dairy products with vitamin C does not only improves the nutritive quality of the product it also increases their acceptability. Yogurt is generally considered to be a relatively poor source of fat-soluble

vitamins, which indicates that its consumption makes a minor contribution to the daily recommended intake of the above- mentioned micronutrients. To overcome this deficit, food manufacturers often add a vitamin fortification step in the process of yogurt manufacture, in order to increase the nutritive value of the end product (Gahruie *et al.*, 2015) [17]. But depending on fat content of milk, dairy products are an important source of liposoluble vitamins, especially vitamin A, D and E and a good source of hydro soluble vitamins, such as vitamin B2, B3 and B12 (Moreno, 2013) [32]. This information goes to tell that the conventional yogurt analyzed are made either from high fat milk or if it were from low fat milk, the products were supplemented with vitamin C and E. That is why the vitamin C and E content of the analyzed samples were high. Vitamins have diverse biochemical functions; they are needed for the metabolism of other nutrients and physiological wellbeing. Primarily, vitamin C and vitamin E act as antioxidants. Habitual consumption of these products will promote positive health outcome, increase immune functions as well as prevent consumers from malnutrition risks.

The mineral analysis of yoghurt samples revealed that the content was high. Gray 2007 [18], asserted that yogurt is a very good source of essential minerals needed for human metabolism or functionality of cells. Large amounts of calcium are needed for maintenance of bone and teeth and normal function of nerves and muscle excitability as well as help release hormones that affect many functions in the body. With the high value of the calcium content, consumers of the products will be free from calcium deficiency which may result to rickets in children, exacerbate osteomalacia caused by vitamin D deficiency in adults and osteoporosis in later life (Blakes *et al.*, 2010) [9], as well as hypocalcemia.

Magnesium, zinc, iron and manganese are important co-factors found in the structure of certain enzymes and are indispensable in numerous biochemical pathways. Furthermore, red blood cells cannot function properly without iron in hemoglobin. Adequate consumption of these yogurt will meet up to one-third of the dietary requirement of these minerals. Sodium and potassium are essential for normal growth. Sodium is the predominant electrolyte in the extracellular fluid while potassium is the major intracellular cation. They are both involved in regulating water and acid-base balance, membrane permeability, nerve conduction and muscle action (Vishwanath, 2012) [39].

Table 1: Micronutrient and macronutrient composition of various yogurt samples

Sample	Vit C(mg)	Vit E(mg)	Na(mg)	Ca(mg)	K(mg)	Mg(mg)	Zn(mg)	Fe(mg)
Z ₁	7.23 ^d ±0.03	9.81 ^d ±0.03	90.8 ^b ±0.02	57.2 ^c ±0.02	54.1 ^d ±0.03	8.62 ^c ±0.02	0.14 ^c ±0.03	0.75 ^b ±0.05
Z ₂	13.1 ^b ±0.10	17.3 ^a ±0.20	37.6 ^d ±0.30	68.7 ^b ±0.20	80.8 ^b ±0.02	10.5 ^b ±0.10	0.22 ^b ±0.01	0.92 ^a ±0.02
Z ₃	7.82 ^c ±0.02	11.9 ^c ±0.10	95.3 ^a ±0.10	51.5 ^d ±0.00	72.6 ^c ±0.10	7.63 ^d ±0.03	0.16 ^c ±0.01	0.94 ^a ±0.00
Z ₄	15.2 ^a ±0.01	13.1 ^b ±0.01	85.5 ^c ±0.02	112 ^a ±1.00	117 ^a ±1.00	14.4 ^a ±0.10	0.30 ^a ±0.01	0.53 ^d ±0.01
LSD	0.1	0.21	0.30	0.96	0.95	0.14	0.03	0.05

Values are means ± standard deviation (SD) of triplicate determinations; values with different superscript within the same column are significantly different $p < (0.05)$.

Four yogurt samples Z₁, Z₂, Z₃ and Z₄

LSD = Least Significant Difference

Proximate composition of yogurt samples

The result of the proximate composition of the different yogurt samples is shown in Table 2. Among the analyzed

samples there was significant difference in the samples. These variations are statistically significant ($p < 0.05$) indicating clear difference in the proximate content among the samples.

The ash and fibre content were remarkably low. Generally, unfortified yoghurts have poor fibre level because they are only milk and water-based products. According to Schneeman (2000), the crude fibre contributes to the metabolic system in man as well as to the overall health of

the gastrointestinal system. The ash value according to Trachoo and Mistry (1998) is an index of mineral content which is needed for bone development, teeth formation and body functions.

The high moisture content of the product is as a result of the reconstitution of the milk prior to fermentation. High moisture in foods is synonymous with high-water activity i.e. the amount of free water in a food medium required for microbial growth, which enhances food spoilage (Awogbenja and Ugwuona, 2012) [6]. But the water found in yogurt is basically bound water, implying that the water is practically unavailable for microbial activity. The quantity and types of solutes in a food such as sugars, gels and salts which binds water thus making it unavailable to microorganisms to cause quality decrease or pathogen increase, determines the shelf life of the product. (Jury and Horton, 2004) [23]. Water is the mise-en-scène for all chemical processes. The excretion of toxic waste from the body and transportation of food nutrients to cells of the body, as well as the maintenance of acid-base balance, proper buffering and electrolyte balance of body fluids is made possible by the process server action of water (James *et al.*, 2002) [22].

The fat level of every yoghurt depends on fat content of the milk, whether skimmed or full cream milk. Dietary fats play important roles in gastric emptying and intestinal motility thereby prolonging satiety, it also provides essential fatty acid and facilitate the absorption of fat-soluble vitamins (FAO, 2013) [16]. This suggests that consumption of these

yogurts may have possible health implication with reference to dietary fat.

Carbohydrate, (lactose) is the major constituents of milk that is converted to lactic acid during yogurt fermentation or production task of the yogurt. So, the fermentation and conversion of lactose to lactic acid accounts for the low carbohydrate content of the yogurt samples. This corroborates with the work of (Heyman, 2000; Vesa *et al.*, 2000) [21, 40] which considers yogurt an ideal food for lactose intolerance individuals. Carbohydrates play important roles in energy metabolism and homeostasis (Ludwig *et al.*, 2018; Zhang *et al.*, 2018) [29, 49]. They serve as source of energy for all body functions, particularly brain functions and are necessary for the metabolism of other nutrients (Ludwig *et al.*, 2018; Lamothe *et al.*, 2019; Buyken 2018) [10, 29]. The consumption of these products will not promote good health among consumers; therefore, other sources of carbohydrate or lactose consumption should be considered.

The analyzed protein content is relatively low, this may be due to the fact that less milk powder was used during the production process and more milk flavour used instead. Protein catalyzes most of the reaction in the living cells and control all cellular processes. It is a key nutrient identified in its role in tissue replacement, immune function, energy balance, bone health, wound healing and cardiovascular functions (Blakes *et al.*, 2010) [9]. From the result of the analysis, the protein content is low and consumers of these products will unlikely meet their requirement for protein, therefore alternatives sources of protein should be sought.

Table 2: The Percentage of Proximate Compositions of Various Yoghurt Samples

Samples	Crude fibre (%)	Ash (%)	Moisture (%)	Fat (%)	Protein (%)	Carbohydrate (%)	Energy (Kcal)
Z ₁	5.15 ^b ± 0.15	5.38 ^b ± 0.08	76.42 ^b ± 0.02	7.96 ^c ± 0.01	0.97 ^c ± 0.03	3.12 ^c ± 0.12	88.00 ^c ± 0.27
Z ₂	4.63 ^c ± 0.06	5.24 ^c ± 0.02	68.87 ^d ± 0.07	10.14 ^a ± 0.14	1.18 ^b ± 0.07	10.94 ^a ± 0.06	139.74 ^a ± 1.78
Z ₃	5.45 ^a ± 0.05	5.76 ^a ± 0.03	81.79 ^a ± 0.09	1.41 ^d ± 0.02	0.08 ^d ± 0.03	1.51 ^d ± 0.03	19.05 ^d ± 0.18
Z ₄	4.59 ^c ± 0.04	5.06 ^d ± 0.04	70.22 ^c ± 0.05	9.60 ^b ± 0.04	1.41 ^a ± 0.03	9.03 ^b ± 0.06	128.16 ^b ± 0.24
LSD	0.16	0.09	0.12	0.14	0.08	0.14 1.72	

Values are means ± standard deviation (SD) of triplicate determinations; values with different superscript within the same column are significantly different $p < (0.05)$.

Four yogurt samples Z₁, Z₂, Z₃ and Z₄

LSD = Least Significant Difference

Conclusion

This study observed that, the four conventional yogurt samples analyzed are high in micronutrients, but it can be made more nutrient dense by enrichment with various fruits and vegetables; such as carrot, coconut, pineapple, apple, strawberry, which are rich sources of micronutrient. The enriched yogurts will be nutritionally and sensorially superior in quality attributes these conventional yogurts. Also, the quantity of added sugars which can have reduced nutritional benefits will be reduced because of the natural sugar content of the enriched fruits. In addition, enriched yogurt corrects the inadequate nutritional value as well as prevent diseases due to malnutrition (Gahruie, *et al.*, 2015) [17].

The macronutrient composition of the conventional yogurt analyzed is low but can be improved by the use of full cream milk in a lesser proportion during the processing, to the non-fat dry milk added during concentration. The use of

full cream milk will increase the fat content, protein content as well as carbohydrate content of the final product. Fat content of products has been reported by other researchers to have positive influence on the physical and sensory characteristics of the product. Its negative impact on the shelf stability of yogurts (Farinde *et al.*, 2009) [15] would be minimal due to the lesser proportion of the addition of the full cream milk to that of non-fat milk during concentration. The fatty-acid profile of yogurt should be taken into consideration for dietary guidelines, while considering the fact that yogurt is associated with better dietary quality and that dairy fat is not associated with obesity in meta-analyses (Kratz *et al.*, 2013; Lu *et al.*, 2016) [26, 28].

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