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Physicochemical Analysis of Locally Made Yoghurt (Kossam) Commercialised in the City of Douala-Cameroon

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Abstract

Yogurt is a traditional dairy product well known in all the regions of the world. In Cameroon, the most popularly known type is "kossam" also called curdled milk. Kossam is a set of milk based beverage from northern Cameroon presenting great symbolic, economic and social values for local population [1]. 150 Kossam samples were collected from neighborhoods of PK8, Bonamoussadi, Nyalla, cite des palmier, Deido and Bedi community and later on reconstituted into 50 different samples of 350 mL, each containing 1/3 of 3 individual samples. They were analyzed for their physiochemical properties such as: PH, titratable acidity, density, brix and dry matter using most at times the standard Association of Official Analytical Chemists (AOAC) methods with slight modifications and results compared to a licensed brand sold in the Cameroonian market. The results of the study showed that, the physico-chemical properties of the locally made yogurts were different within the different samples. Analysis of variance revealed a significant difference in the levels of the parameters analyzed in the different yogurt samples ($p < 0.05$). The results of this study revealed for all samples an acid PH (3 - 4), titratable acidity (5% - 15%), density (10 - 13 × 10^{-1} Kg/L), Brix (8˚ - 24˚B), Dornic (23˚ - 160˚D). others contents per 100 g fresh matter are as follows: dry matter (average mean of 16.54%). Hence, the significant variations in the physico-chemical properties of kossam are a call for concern since as it impacts on the health of the population consuming this product.

Keywords

Kossam, Physicochemical Analysis, Brix, Titratable Acidity

1. Introduction

Milk is a highly nutritious diary product that can be obtained from a variety of animal sources such as cows, goats, sheep, and buffalo, as well as humans, for human consumption [2]. Fermented milk products are claimed to have high vitamin and mineral contents along with reduced fat contents and offer tremendous potential for promoting heath and reducing the risks of various bottles prepared under unhygienic conditions have been found to be grossly contaminated [3]. Yogurt is a good source of calcium because its absorption is facilitated by galacto-oligosaccharides and casein phosphopeptides in dairy products [4]. Yogurt, like milk, also contains high levels of short-chain fatty acids [5]. Milk protein is rich in essential amino acids for humans and has a very good ratio at which it is absorbed and taken up into the body. To reflect this, the digestible indispensable amino acid score of milk protein is particularly superior among these major protein sources [6]-[8]. Total milk protein is composed of casein and whey proteins at an approximate 8:2 ratio. Casein proteins consist of alpha-, beta-, and kappa-casein, and these caseins are present in a uniform colloidal dispersion in milk by forming micelles together with calcium phosphate [9]. Whey protein is composed of approximately 50% β-lactoglobulin (β-Lg), 20% - 25% α-lactalbumin (α-La), and 25% - 30% other proteins, including serum albumin, immunoglobulin, and lactoferrin; these whey proteins are water soluble [10]. Whey is a by-product of cheese production, but whey proteins have a high content of essential amino acids, such as branched-chain amino acids (BCAAs), giving whey its high nutritional value. Therefore, these proteins are refined as whey protein concentrate or whey protein isolate, which are used as protein sources. β-Lg is rich in BCAAs, among other proteins, but is potentially the cause of bovine milk allergy because it is not present in human breast milk [11].

When KOSSAM is well made, it is uniform, dense and white. For the majority of pastoral and agro-pastoral population, KOSSAM is a symbol which represents an essential component in the daily food rationing, it is an important source of income and a drink of great social value consumed by all ages [12]. As from 1917, gradual introduction and refinement of pasteurization methods throughout the United States and many other parts of the world have improved the safety and quality of milk and dairy products. In parallel to pasteurization, others strategies for reducing microbial contamination all through the dairy chain (e.g., improved dairy herd health, raw milk tests, clean-in-place technologies) also played an important role in improving microbial milk quality and safety [13]. Microorganisms can bring about the fermentation of milk (e.g. *lactococcus*, *lactobacillus*, *streptococcus*, and fungal population), causing spoilage (e.g. *pseu-*

domonads, *clostridium*, *bacillus* and other spores forming or thermoduric Microorganisms), promoting health (e.g. *lactobacilli* and *bifidobacteria*) or causing disease (e.g. *listeria*, *salmonella*, *Escherichia coli*, *campylobacter* and mycotoxin-producing fungi) [2]. For centuries, milk production in Cameroon has been characterized by the traditional system using local Zebu cows (Gudali, white Fulani, Red Fulani). However, this production has been insufficient reaching only an average of 3 liters per cow per day [14]. Compared with an average of 210 kg in the developed countries, milk consumption per capital output in Cameroon is approximately 10 kg, while per capital out production is only 5.11 kg [15]. This difference in consumption could be made up by dairy imports, which are continually increasing. Thus, special attention needs to be given to developing dairy production in the country. Hence, due to the little knowledge in the quality control of dairy products in Cameroon as well as limited equipment availability for quality control, our research was aimed at contributing to the quality control of locally made yogurt commonly called "KOSSAM".

2. Material and Methods

Generally, the local methods for quality control of KOSSAM once prepared is based on the organoleptic properties such as the smell, the texture, the color as well as the thickness (viscosity) amongst others. To note here that these local quality control validation parameters are not enough to determine the quality of Kossam.

2.1. Methods for the Ph Determination

The pH measurement is performed by a potentiometric method according to the Protocol. Reference *Fiju N°* 11, 1968/1989 presented below in two steps.

Step 1/2: CAL calibration meter

The ph meter after rinsing with distilled water is initially calibrated by introducing the probe into deionized water for 1 min and then introduced in 50 ml of a pH 7 buffer solution and switch to calibration mode.

Step 2/2: PH measurement

The probe is again rinsed in distilled water and is introduced in 50 ml of sample (yogurt). The pH value is directly read on the device display table after stability of the sample.

2.2. Methods for Brix Determination [16]

The measurement of Brix is determined by the use of a refratometer according to method used in [16] with slight modifications, the steps are shown below:

Step 1/2: Refractometer calibration

- Remove the protection ribbon on the measuring surface. Then clean the measuring surface with clean industrial paper.
- Drop 30 to 50 µl distilled water on the measuring surface then close.
- Open the illumination window, observe and adjust the contrast using the

adjustment and displacement screws on the right side of the device. Adjust the contrast to the lower half of the adjustment circle.

Step 2/2: Measuring brix

- Clean the measuring surface with clean industrial paper.
- Remove 50 µl of sample, place on the measuring surface and close.
- Open the illumination window and adjust the contrast as described above to the lower half of the adjustment circle.
- Read and meet the values of Brix (top graduation) and the refractive index (lower graduation).

2.3. Methods for the Dornic Acidity Determination (AOAC, 2005) [16]

The acidity of a product is associated with the quantity of organic acid content added or that which originates from the raw material, principally, acetic acid, citric or lactic acid in the case of yoghurt. The acidity is generally determined by titration methods with respect to the protocol described in the French norms NF V04-206. This later consists in collecting 2.5 mL of the product (KOSSAM) and diluting it in 22.5 mL of distilled water (Dilution factor of 10). 2 to 3 drops of the indicator (Phenolphthalein 3.5% prepared with ethanol at 95%) is added to the solution. This later is then titrated with the NaOH at 0.1 N ran down from the burette. The equivalence point is determined by the change in colour (persistent pink coloration for over 30 mins) of our sample.

Expression of results: The Dornic degree (˚D) which corresponds to 0.1 g of lactic acid per liter of yoghurt, is calculated after determining the mass concentration C_0 in (g/l) lactic acid in the yogurt according to the formula if against:

$C_0 = C_1X$ Véq X Mac/V_0X fd with:

C_0 = Lactic acid concentration (G/L): C_1 = NAOH concentration at equivalence (0.25 m): Véq = NAOH volume in equivalence: Mac = Pondera Concentration Lactic Acid (90.03 g/l): V_0 = Volume of milk analyzed (40 ml).

2.4. Methods for Density Determination

The gravimetric method described in the French norm NF T 60-214 (AFNOR, 1984) at 20˚C was used for this experiment. It required us to weigh the samples of yoghurt in a volumetric flask of 20 mL on an electronic balance. The density was obtained as shown in the formula:

Yogurt Density = mass sample/mass of water (Kg/L)

2.5. Methods to Determine the Dry Mater (Ash) Contents

Dry matter or ash is the inorganic residue obtained by burning off the organic matter of feed stuff at 400˚C - 600˚C in muffle furnace for 4 hours. 2 g of the sample was weighed into a preheated crucible. The crucible was placed into muffle furnace at 400˚C - 600˚C for 4 hours or until whitish-grey ash was obtained. The crucible was then placed in the desiccator and weighed [17].

$$\% \text{ Dry mass} = (m_2 - M_0) \times 100/m_1$$

where m_0 = weight in grams of the empty Capsule; m_1 = weight in grams of the test prius before drying; m_2 = Weight in grams of the testing after drying.

2.6. Statistical Analysis

The statistical analysis of the results was performed using the Graph Pad Prism 8.0.1 (244) software, and the results were presented as mean ± standard error on mean (SEM), for a number of n = 10 samples per set of 4 and 5. After analyses of variances using one-way analysis of variance test, multiple comparisons of averages were achieved using nonparametric Turkey test. The significant differences were considered at the level of $P < 0.05$.

2.7. Data Collection and Results

The samples used for this experiment were collected from some neighborhoods in Douala such as: PK8, Bonamoussadi, Nyalla, Cite des palmier, Deido, Bedi. A total of over 150 samples were collected and grouped up into 50 samples of 3 of 1/3 the volume of each 150 samples. They were conserved in the fridge for 3 days prior to the different experimentations in the laboratory.

3. Physiochemical Analysis Results

3.1. Results for the PH Determination

A repeated measures ANOVA was performed to compare the effect of pH on KOSSAM. No significant difference was observed with respect to the brand, we noted a significant difference between measures of samples two and three with respect to the fourth sample and possessing adjusted p values of 0.0020 and 0.0081 respectively.

3.2. Results for the Determination of Acidity Contents

A repeated measures ANOVA was performed to compare the effect of titratable acidity on KOSSAM. No significant difference was observed with respect to the brand we however, noted a significant difference between measures of samples two and three with respect to the fourth sample and possessing adjusted p values of 0.0008 and 0.0007 respectively.

3.3. Results for the Determination of the Dornic Degree

A repeated measures ANOVA was performed to compare the effect of Dornic acidity on KOSSAM. There was no statistical significant difference in Dornic acidity variation.

3.4. Results for the Determination of the Brix Degree

A repeated measures ANOVA was performed to compare the effect of the brix acidity on KOSSAM. There was a statistically significant difference in Dornic

acidity variation between the second sample and the brand, the third, the fourth and the fifth set samples with respective adjusted p values as follows; 0.0003, <0.0001, 0.0001, 0.0003.

3.5. Results for the Determination of the Density

A repeated measures ANOVA was performed to compare the effect of the density on KOSSAM. There was a statistically significant difference in Dornic acidity variation between the third set sample and the brand, the fourth and the fifth set sample with respective adjusted p value as follows 0.0040, 0.0261 and 0.0445. We also noticed a significant difference between the brand set and the second set samples with adjusted p value of 0.0429.

3.6. Results for the Determination of the Percentage Dry Mass

A repeated measures ANOVA was performed to compare the ash content variation in KOSSAM. There was a statistically significant difference in Dornic acidity variation at least two groups ($F(1.000, 9.000) = 192.7$, $p < 0.0001$).

4. Discussion

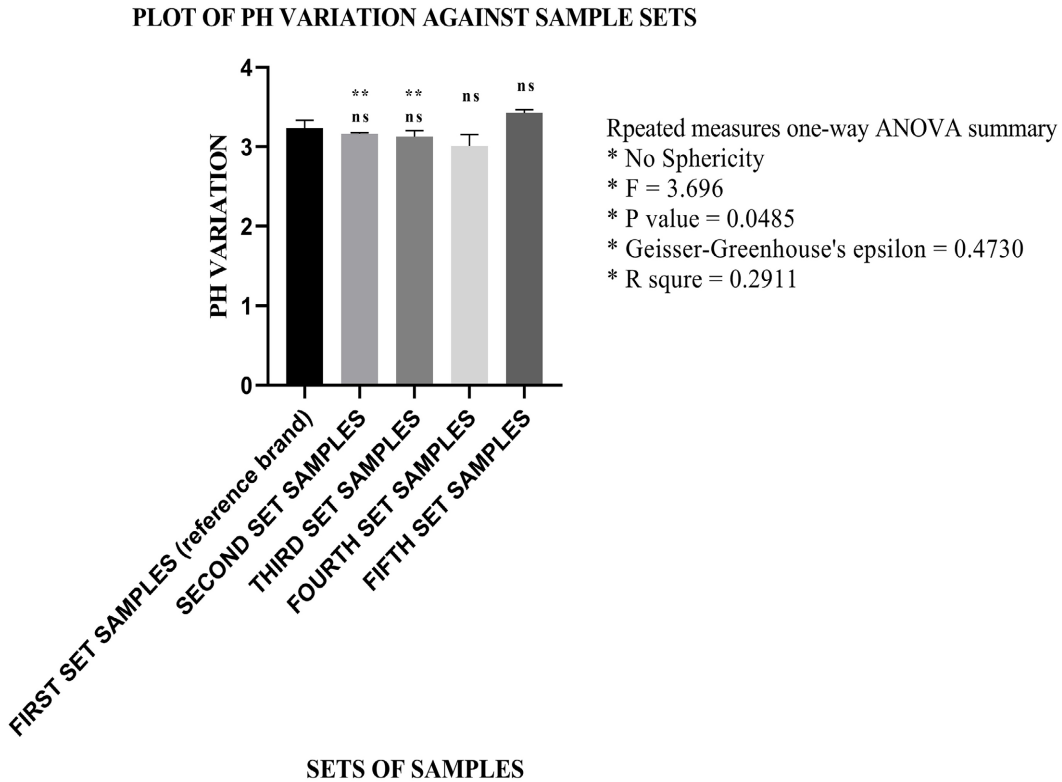

Figure 1. pH variation of yoghurt samples against the different sets of ten samples each.

PH: The pH values obtained from our analysis (**Figure 1**) varied between 3 and 4 which expresses the acid nature of our different samples. These results are far much lesser than those obtained by Djoulde and collaborators in 2003 [18] in

kossam samples collected in Maroua-Cameroon. Generally, the reduced pH in artisanal yogurts "kossam" is due to the activity of microorganisms and lactic bacteria in particular which sometimes exist in large numbers in these products which are obtained under uncontrolled conditions. These conditions concern: the starter impurity, which is made up of part of the previous preparation for incubation and uncontrolled conditions, storage and conservation conditions, and the hygienic quality of the containers. All these factors can have a positive impact on the activity of organic acids by microorganism present in kossam.

Titratable acidity: Titratable acidity designates the level of lactic acid produced during fermentation. There is a slight difference in titratable acidity in these samples (Figure 2). The value of these parameters varied between 5 % and 15 % of lactic acid. These values compared to the standard values applicable in East Africa which is at least 0.6% of titratable acidity in yogurts are significantly very high. These values were quite different "high" compared to the results obtained by (Tagne *et al*., 2021) [12]. These differences may be due to the long storage periods of our samples leading to high acid level as describe by (Miguel *et al*., 2003) [19].

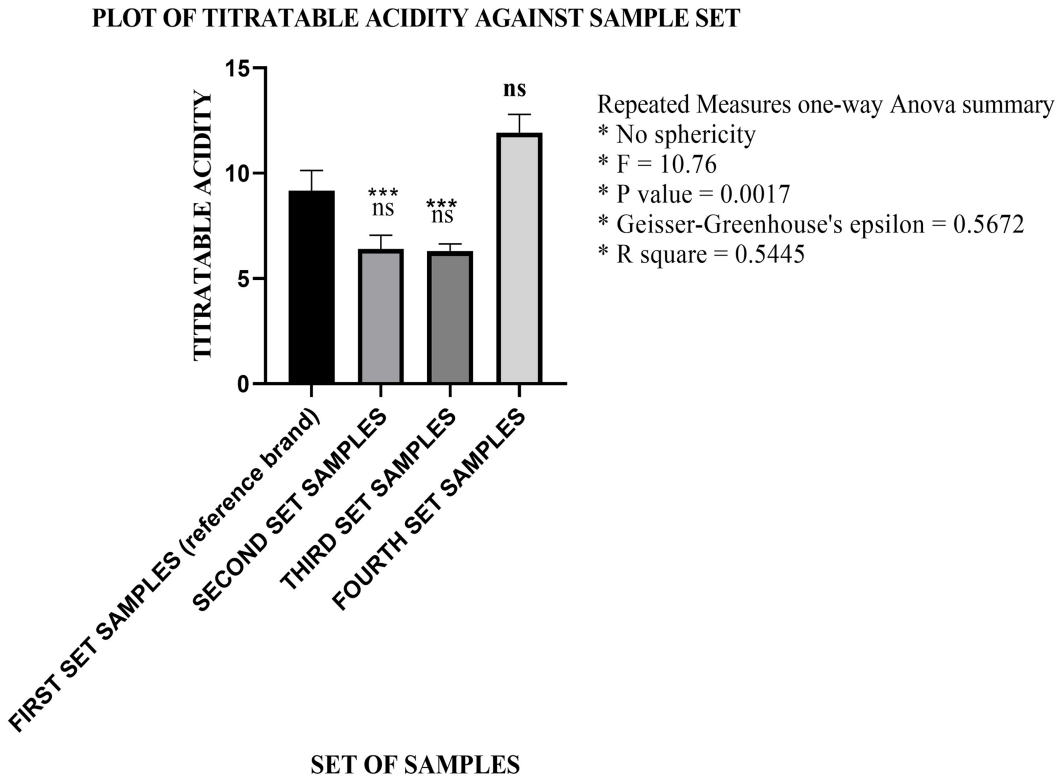

Figure 2. Titratable acidity variation of yoghurt samples against the different sets of ten samples each.

Brix and Dornic acidity: The Dornic acidity ranged between 23˚ and right up to 160˚D (Figure 3) while the results of brix obtained ranged between 8˚ and 24˚ brix (Figure 4).

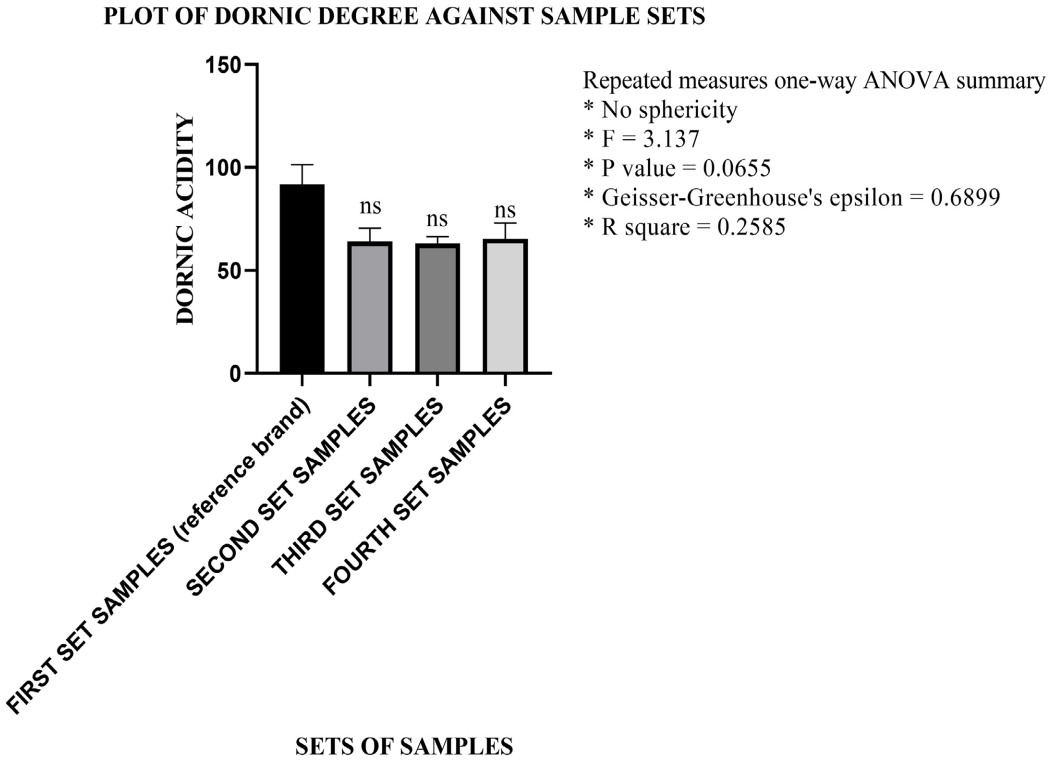

Figure 3. Dornic acidity variation of yoghurt samples against the different sets of ten samples each.

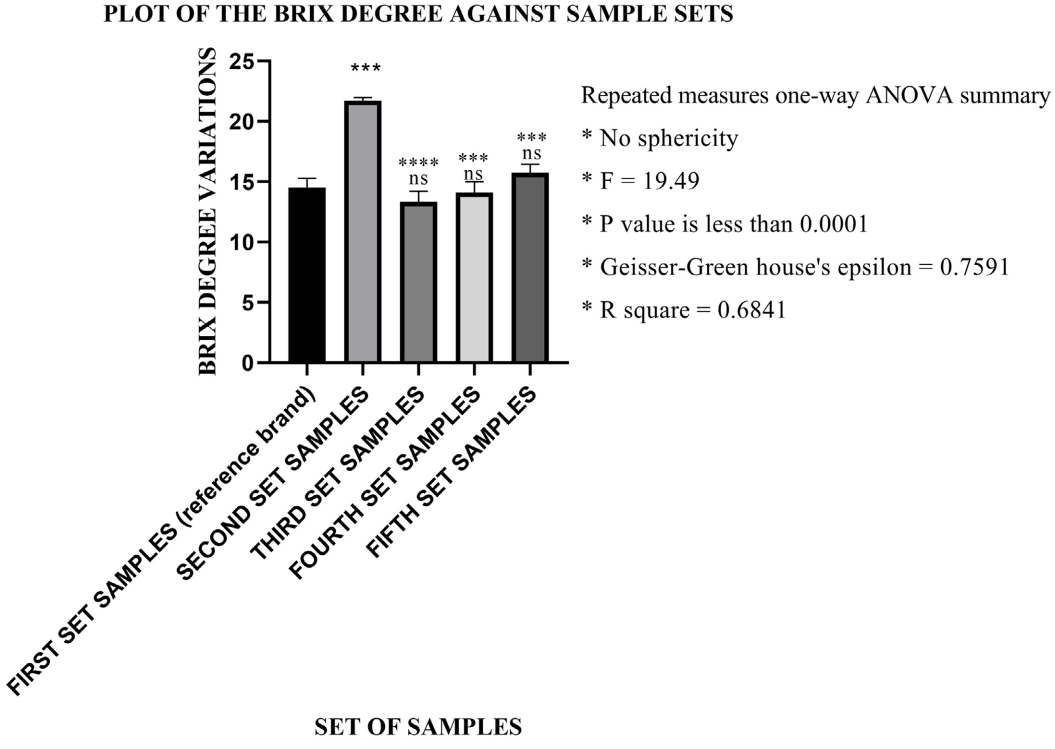

Figure 4. Brix degree variation of yoghurt samples against the different sets of ten samples each.

Density: the density obtained for over 50 samples ranged between (10 and 13) $\times 10^{-1}$ Kg/L (**Figure 5**).

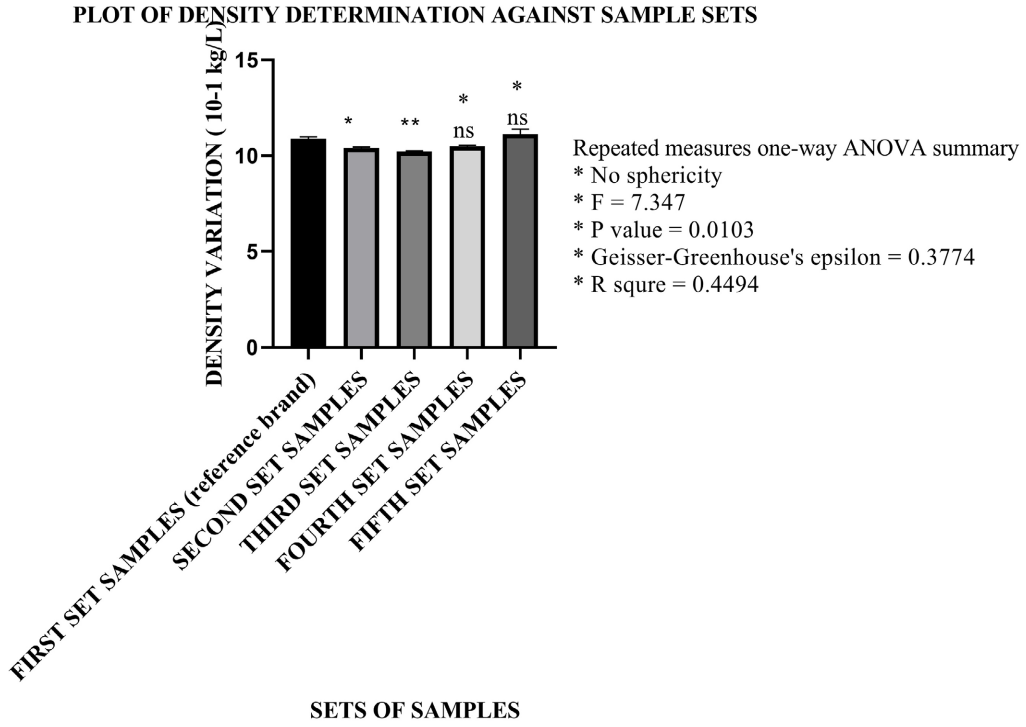

Figure 5. Density variation of yoghurt samples against the different sets of ten samples each.

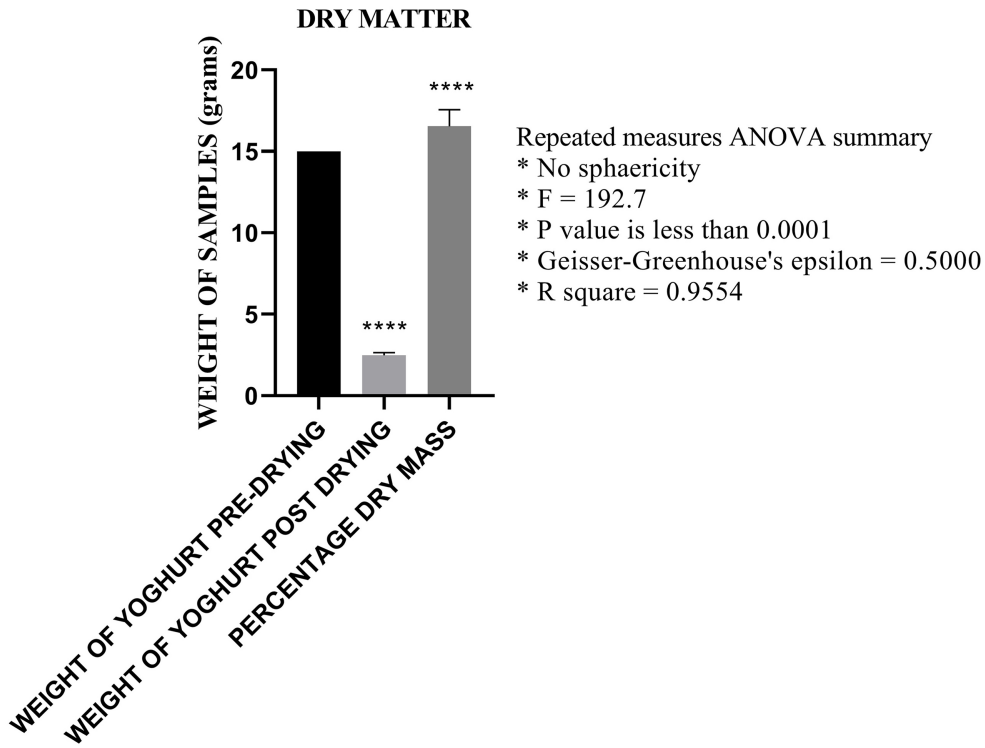

Figure 6. Dry matter (Ash content) of yoghurt samples against the different sets of ten samples each.

Dry mater (Ash) contents: the mean percentage of dry matter or total solid contents (TSC) of 30 locally made yogurt samples was found to be 16.54%

(**Figure 6**). TSC of yogurt is known to have significant effects on the degree of syneresis (Shaker *et al*., 2000) [20]. The values obtained were reasonably low as compared to the results obtained by (Lamye *et al*., 2017) [21] but rather very similar to the findings of (Amy *et al*., 1994) [22] having values between 15% and 16% and (Muhammed *et al*., 2005) [23] who reported a higher total solid content of 17.11%. However, in the article published by (Weaver *et al*., 2022) [24], it was reported that low percentage of TSC in yogurt may lead to a malfunction of the starter culture.

5. Conclusion

Dairy products in general and yogurt (notably KOSSAM) in particular, areimportant sources of nutrients for all age groups of the population. Kossam produced and marketed in the neighbourhoods of: PK8, Bonamoussadi, Nyalla, cite des palmier, Deido and Bedi community have shown a great difference in their physicochemical property, with relatively high acidity concentrations (titratable acidity, Dornic and Brix degree) and high density variations which could be explained by the low dry matter content or low Total Solid Content (TSC) and thus, high water content in which case an increase in the density. Nonetheless, a low pH was observed. Hence, with the observed variations in the physicochemical properties of Kossam and a plausible impact on the nutritive content as well as the health impact on the consumers. It can be concluded that the overall picture of the quality assessment of locally made yogurt in the PK8, Bonamoussadi, Nyalla, cite des palmier, Deido and Bedi community needs emphasis on quality control during processing and storage.

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Data Availability

All data generated or analyzed during this study was included in this Original Research Article.

Authors' Contributions

SADJEU TCHAKOUNTE Sidonie, KANG COSTLY EHA-KANG, NGOLE HUMPHREY and SIEWE François designed and carried out the study, SADJEU TCHAKOUNTE Sidonie and KANG COSTLY EHA-KANG, wrote the Original Research Article, SONE ENONE Bertin supervised the work, WABO JORDAN, FOKAM SANDRA, PENN Blandine, NJUIKUI THELMA, TCHEUFFA RODIAH Fresnell helped in sample collection. All authors have read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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