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COMPARATIVE PHYSICO-CHEMICAL PROPERTIES, AMINO ACIDS AND VOLATILE COMPONENTS OF YOGHURT PRODUCED FROM COW, GOAT, AND CAMEL FRESH MILK

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ABSTRACT

The study evaluated and compared the physicochemical properties, amino acid profiles, volatile compounds, and organoleptic characteristics of yoghurts produced from fresh camel, sheep, and cow milk to determine their respective quality profiles. Fresh milk was obtained from camels, sheep, and cows, then pasteurized and processed into yogurt using a Yogourmet® starter culture containing active bacterial cultures (*Lactobacillus bulgaricus*, *Streptococcus thermophilus*, and *Lactobacillus acidophilus*). The yogurts were analysed for physicochemical properties (pH, Brix, specific gravity, viscosity, total solids, moisture, and lactic acid), amino acids, sensory attributes, and volatile compounds using standard methods. The physicochemical parameters ranged as follows: pH (4.32- 4.50), specific gravity (1.030 – 1.038), brix (18.20 – 21.00%), moisture (71.00 – 74.20 %), total solids (25.80 – 29.00 %), lactic acids (0.85 – 0.95 %), and viscosity (4450 – 4000 mPa.s). Camel milk yoghurt showed highest proportions of most of the essential and non-essential amino acids. The volatile compounds identified in the yogurts were classified as alcohols, aldehydes, acids, esters, and aromatic compounds. Specifically, aldehydes (including furan, hexanal, heptanal, octanal, and decanal) and esters (such as ethyl acetate, ethyl propionate, ethyl hexanoate, ethyl octanoate, and ethyl butyrate) were primarily responsible for the flavor profiles of the yogurts, based on their relative proportions. Ethyl pyrazine, 2 – Acetyl – 1 – pyrroline, Benzyl alcohol were aromatic compounds identified. Sheep milk yoghurt was the most viscous, smooth, and spreadable with a robust flavour, while cow milk yoghurt achieved the highest overall acceptability due to its balanced flavour and absence of off-flavours. Camel milk yogurt was characterized by a thinner, more watery consistency and a more pronounced sourness, but sweet than the other samples. All the samples were acceptable.

Keywords: Camel milk yogurt; Physicochemical properties; Amino acid profile; Volatile compounds; Sensory evaluation

INTRODUCTION

Milk from camel and goat are considered unconventional sources of milk compare to cow's which serves as major source of milk in the domestic and industrial productions in Nigeria (El Zubeir, 2012). Yoghurt is one the major dairy product from milk cherished for its taste but also appreciated for its potential health benefits. The preparation process involved the fermentation of milk by specific bacterial cultures, predominantly *Lactobacillus bulgaricus* and *Streptococcus thermophiles*, leading to conversion of lactose, the milk sugar; into lactic acid, which thickens the milk and gives yoghurt its characteristic texture and tangy flavour (Shivana *et al.*, 2024).

The major sources of milk are mostly from cow, sheep, goat, or water buffalo. The choice of milk source varies from one country to another. Milk from cow is popularly used in the United States and north-central Europe; sheep's and goat's milk are more preferred in Turkey and southeastern Europe, while milk from the water buffalo is most commonly used in Egypt and India (Shivana *et al.*, 2024). Other animals also produce milk but rarely in commercial quantity and literatures have identified production of yoghurt from non-dairy products such as soymilk, coconut and functional plant-based extracts (Stojanova *et al.*, 2025; Opara *et al.*, 2013). The sources of milk for yoghurt in Nigeria are based on country of

importation and are mainly cow milk products. Domestic production of fresh milk is undertaken by herders whose wives traditionally process the milk into various products such as *warankasi*, *fura de nunu* and so on for livelihood.

Yoghurt is a nutrient-rich food, providing essential nutrients such as calcium, protein, and probiotics. According to Reeta *et al.* (2015) and Martin *et al.* (2005), the nutritional composition of yoghurt depends on the strains of starter culture used in the fermentation, the type of milk used (whole, semi skimmed, or skimmed milk), the species of animal from which the milk is obtained, the type of milk solids, and also, with genetic and non-genetic factors. The milk from different animal sources contributes distinct flavour and aroma to yoghurt (Watkins *et al.*, 2021; Fresno *et al.*, 2020). Therefore, there is a need to research on quality of yoghurt from major and non-major sources of milk from various animal sources in Nigeria.

The increasing global demand for dairy products has led to interest in understanding the principal components of milk and those responsible for their aromatic quality (Grout *et al.*, 2020). Determination of volatile components of yoghurt produced from non-traditional milk sources, such as sheep and camel milk would provide information on chemical components responsible for certain characteristics of yoghurt. A comparative study of these yoghurt products

would help to deepen understanding of differences among yoghurts from the milk of these mammals and increase knowledge of the quality characteristics of specialty dairy products. The objective of the study was to evaluate and compare the physico-chemical, amino acid profile, volatile components and sensory evaluation of yoghurts produced from cow, camel and sheep milk.

MATERIALS AND METHODS

Materials

Fresh milk was obtained from Uda local breed of sheep, camel milk from Fari dromedary (one humped) breed of camel and cow milk from white Fulani (bunaji) breed obtained from Fulani herdsman raising the livestock in Gashua. A brand name of starter culture, Yogourmet® containing active bacterial cultures (*Lactobacillus bulgaricus*, *Streptococcus thermophilus*, *Lactobacillus acidophilus*, maltodextrin and sugar) was purchased from a supermarket in Kano and other materials were sourced from Modern market in Gashua, Yobe State.

Yoghurt processing

The method by Adepoju and Selezneva (2020) was used for the production of yoghurt according to the international standards for yoghurt manufacture. A liter (1000 ml) of fresh milk sample was measured into 2.5 L uniform bowl. The milk was homogenized, pasteurized at 90 ± 2 °C for 5 min, and cooled to 40 ± 2 °C. Then, a sachet of 3 g of lyophilized powder of Yogourmet® starter culture was mixed with 10 ml portable water and inoculated into the pasteurized milk, mixed thoroughly and incubated at 40 ± 2 °C for 6 h. After incubation, yoghurt was rapidly cooled to 4 °C to stop fermentation. The yoghurt was stored at the same temperature for analysis.

Physical and chemical parameters

pH measurement

The pH was measured with a digital pH meter (FE28-Standard, METTLER TOLEDO, America) (Akinlabi *et al.*, 2019).

Determination of specific gravity (SG)

The specific gravity was determined as described by Olugbuyiro and Useh (2011). A 50 ml specific gravity bottle was weighed and the weight recorded as 'A'. The bottle was then filled with water, and also weighed. The value obtained was recorded as 'B'. The bottle was emptied, dried, cooled and filled with the yoghurt sample and weighed. The value obtained was also recorded as 'C'. Specific gravity was then calculated as:

$$SG = \frac{C-A}{B-A}$$

The result was compared to the standard SG value for yoghurt (1.030 kg/m³).

Refractive index

The refractive index or the brix content of the yoghurt was determined using the method described by Mbam and

Ekwu (2021). The Abbes refractive meter was calibrated with distilled water in a light compensator; the sample was smeared on the lower prism of the refractor meter and closed. A light passed by the means of the angled minor while the self-elected light appeared in form of a dark background which was fine adjusted by moving the telescope tube until the black shadow appeared on the central of the cross-line indicator. The reading of the refractive index was then taken on the screen at specific temperature 25 °C.

Determination of moisture composition

The moisture content of the yogurt products was determined according to the Association of Official Analytical Chemists method (AOAC, 2000). A 10 g sample of yoghurt was weighed into a pre-weighed, dried aluminum can. The sample was placed in an air oven at 105 °C for 3 h, cooled in a desiccator, and weighed again. This process was repeated until a constant weight was obtained. The moisture content was then expressed as the percentage (%) of the dry weight of sample.

Determination of the total solids

Total solids (T.S) content was determined according to AOAC (2000). Clean aluminum moisture dishes were dried at 105°C for 3 h. Five grams of the dairy sample was weighed in the aluminum dish and heated on a steam bath for 15 min. The dish was placed in a hot air oven at 100 °C for 3 h. Then cooled in a desiccator and weighed quickly. Weighing was repeated until the difference between two readings was less than 0.001 g to confirm a constant weight has been achieved. The total solids content is estimated as the percentage of the dried residue weight relative to the initial weight of the wet dairy sample.

$$\text{Total solid \%} = \frac{w_1}{w_2} \times 100$$

Where: W1=Weight of sample after drying
W2=Weight of sample before drying

Determination of lactic acidity

The lactic acidity was determined by weighing 15 g of yoghurt into a 250 mL beaker and adding approximately four drops of phenolphthalein indicator. The sample was titrated by adding 0.1 M NaOH gradually with continuous mixing until the solution changed from colourless to a persistent light pink. The volume of NaOH consumed was recorded, and the lactic acid percentage was calculated using the formula:

$$\text{Lactic acid, \%} = \frac{V \times N \times 90.08 \times 100}{M \times 1000}$$

Where, V= Volume of NaOH used for titration; N = normality of titrant, NaOH solution; 90.8 = Equivalent

weight for lactic acid; Mass of sample = Mass of the milk sample used

Determination of viscosity of yoghurt

The viscosity of the samples was determined using digital display viscometer (model NDJ85) Brookfield DV-II as described by Mbam and Ekwu (2021), with minor modifications. The temperature of the yogurt samples was maintained at 25 ± 2 °C using a water bath (Model: Ambassador). The viscosity of the samples was measured at a constant speed (60 rpm) using spindle No. 2. The sample was brought to the level of the immersion groove on the spindle shaft. The final viscosity value was calculated by multiplying the dial reading by the appropriate factors supplied with the viscometer. The results were recorded in mPa.s.

Determination of amino acids in yoghurts

HPLC was used for amino acid profiling as described by Germini *et al.* (2014). The sample was analyzed by High-Performance Liquid Chromatography (HPLC) using a Buck Scientific BLC 10/11 system equipped with a 338 nm UV detector. The process involved protein hydrolysis, followed by separation, detection, and analysis. Free amino acids in the yoghurts were extracted in an acidic solution after proteins were precipitated with sulfosalicylic acid. The sample was prepared and passed in the chromatography column after derivatization with o- fthaldeide (OPA). The amino acid content was expressed in mg/100g of product.

GC-MS analysis

Volatile compounds in yoghurt samples were analysed using a Shimadzu GCMS-QP2010 Plus gas chromatography-mass spectrometry (GC-MS) system, equipped with an OI 4660 'Eclipse' Purge and Trap Concentrator and an OI 4551A autosampler (Sakamoto *et al.*, 2010). The temperature profile ranged from 35–220 °C, and the advanced flow control (AFC) was set to a constant linear velocity of 35 cm/sec. The total analysis time was 12.5 min, resulting in a GC cycle time that approximately matched that of the purge and trap concentrator. The mass spectrometer operated in full-scan mode from m/z 36 to 260 with 0.5-second scan intervals. Volatile components were identified by searching and matching spectra against the NIST and Wiley MS libraries. Quantitation was performed using peak area normalization. The detector (electron multiplier) was adjusted to provide an adequate response at the lowest calibration level while avoiding saturation at the highest level.

Sensory evaluation

Yoghurts were evaluated by 50 panelists who consumed yoghurt regularly or occasionally and had previous taste panel experience. Descriptive sensory analysis was performed using a 150-mm line scale to assess firmness (low to high), graininess (smooth to coarse), and textural

preference (dislike to like). All samples were evaluated in duplicate.

Statistical analyses

The data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 11.5. Fresh milk data were compared using an independent t-test, while yogurt data were analyzed with a completely randomized design (CRD) and analysis of variance (ANOVA). Treatment means were separated using Duncan's Multiple Range Test (DMRT) at a significance level of $p < 0.05$.

RESULT AND DISCUSSION

The physical and chemical properties, amino acid qualities and sensory characteristics of yogurt from camel, sheep, goat, and cow milk were compared.

Physico-chemical properties of yoghurts

The results showed significant differences ($p < 0.05$) in the physico-chemical properties of yoghurts from cow, camel and sheep. The pH values indicated significant differences ($p < 0.05$) among yoghurt samples (Table 1). Camel milk yoghurt has the lowest pH (4.32 ± 0.12), followed by sheep (4.45 ± 0.15), and cow milk yoghurt (4.50 ± 0.12). These values conformed to the standard yoghurt pH range of 3.5–4.5 established by Akinlabi *et al.* (2019), indicating that all samples maintained acceptable acidity levels. Specific gravity values show significant differences ($p < 0.05$) among yoghurt samples. The recorded SG values were 1.030 ± 0.005 , 1.035 ± 0.006 and 1.038 ± 0.006 for camel, sheep and cow milk yoghurts respectively. These findings align with the benchmark SG of approximately 1.030 and are consistent with the results previously reported by Chandan and O'Rell (2013).

Total Soluble Solids (TSS), measured in °Brix, represent the concentration of dissolved solids within a food product. In this study, cow milk yoghurt exhibited the highest TSS content ($21.00 \pm 0.50\%$), whereas camel milk yoghurt recorded the lowest. Following the methodology described by Othman *et al.* (2019), °Brix was utilized as a proxy for sugar content. The TSS values observed in the current study exceed those reported by Othman *et al.* (2019) but are consistent with the findings of Gupta *et al.* (2022).

Camel milk yoghurt has the highest moisture content ($74.20 \pm 0.50\%$), followed by sheep milk yoghurt ($72.00 \pm 0.60\%$), and cow milk yogurt ($71.00 \pm 0.50\%$). The result of the moisture is lower compare to the report of Arain *et al.* (2024) but also reflected that camel milk yoghurt exhibits higher moisture and lower total solids compared to other type yoghurts from other ruminant milk. Camel milk yogurt has the lowest total solids content ($25.80 \pm 0.50\%$), followed by sheep milk yogurt ($28.00 \pm 0.60\%$), and cow milk yogurt ($29.00 \pm 0.50\%$). This agrees with previous findings of Chandan and O'Rell (2013).

Lactic acid is one of the metabolites produced during the fermentation process. Lactic acid is the result of bacterial

metabolism in yoghurt starter (*Lactobacillus bulgaricus* and *Streptococcus thermophilus*) where lactose is an energy source for bacteria (Azwa *et al.*, 2021). Camel milk yoghurt has the lowest lactic acid content ($0.85 \pm 0.05\%$), followed by sheep milk yogurt ($0.90 \pm 0.06\%$), and cow milk yoghurt ($0.95 \pm 0.06\%$). According to Azwa *et al.* (2021), the standard level of lactic acid is in the range of 0.5-2.0%. It showed that all the yoghurts from different sources of milk met the standard. Lactic acid gives yoghurt the characteristic acidic taste which tends to increase with fermentation period (Anumudu *et al.*, 2024). Yoghurt is a dairy product whose viscosity depends on factors such as its ingredients, concentration, temperature, etc. Viscosity

measures whether the product is lumpy or smooth, watery, or too thick. Viscosity values show significant differences at ($p < 0.05$) among yoghurt samples. The result revealed camel milk yoghurt has the least viscosity (3450 ± 120 mPa.s), sheep milk yogurt (3820 ± 150 mPa.s), and cow milk yogurt (4000 ± 120 mPa.s). In term of texture, the result depicts that cow milk yoghurt is the thickest in texture compared with others. The viscosity of camel yoghurt from this study is lower than the result (6047.3 ± 368.0 cp) documented by Kabir *et al.* (2022). The variations could be due to genetic and non-genetic factors as described by Adamu *et al.* (2021). However, this agrees with previous findings of Park (2007).

Table 1: Physico-chemical properties of the yoghurts

Parameters	Camel milk yoghurt	Sheep milk yoghurt	Cow milk yoghurt
pH	$4.32 \pm 0.12c$	$4.45 \pm 0.15a$	$4.50 \pm 0.12a$
Specific gravity (%)	$1.030 \pm 0.005c$	$1.035 \pm 0.006a$	$1.038 \pm 0.006a$
Brix (%)	$18.20 \pm 0.50c$	$20.50 \pm 0.60a$	$21.00 \pm 0.50a$
Moisture content (%)	$74.20 \pm 0.50c$	$72.00 \pm 0.60a$	$71.00 \pm 0.50a$
Total solids (%)	$25.80 \pm 0.50c$	$28.00 \pm 0.60a$	$29.00 \pm 0.50a$
Lactic acid (%)	$0.85 \pm 0.05c$	$0.90 \pm 0.06a$	$0.95 \pm 0.06a$
Viscosity (mPa.s)	$3450 \pm 120a$	$3820 \pm 150c$	$4000 \pm 120a$

Amino acids profile

The amino acid profile showed significant variations in essential and non-essential amino acids from cow, sheep, goat, and camel milk-based yoghurts (Fig. 1 and 2). The yoghurt products were rich in all the nine essential amino acids. Highest amount of tryptophan (6.83 mg/100), isoleucine (5.08 mg/100g), phenylalanine (8.315 mg/100g), valine (5.7 mg/100g), methionine (7.33 mg/100g) threonine (7.04 mg/100g) and lysine (5.515 mg/100g) were found in camel milk yoghurt compare to that of cow and sheep. A good composition of essential amino acids support muscle protein synthesis, tissue repair, and improved metabolic health due to their high digestibility (Sumi *et al.*, 2023). According Gyawali *et al.* (2022), it was documented that variations in the nutrient composition could be influenced by a complex inter play of factors such as animal species and breeds, animal feed, the starter culture and processing conditions. These factors have been found to also affect the physico-chemical (pH, acidity, viscosity), textural, and organoleptic properties. Protein and amino acids are among the important indicators of yoghurt. These indicators provide essential or non-essential amino acids and other

nutrients to be utilised by the body (Day *et al.*, 2021). Amino acids are also precursors of aromatic compounds in yoghurt, which give yoghurt different flavours (Terzioğlu *et al.*, 2023).

The camel yoghurt non-essential amino acids (NEAAs) are found in high contents compared to that of cow and sheep milk yoghurt. According to Wang *et al.* (2023), camel yogurt is considered to be generally superior with more diverse amino acid profile compared to cow yoghurt. Camel milk yoghurt exhibited the highest concentrations of alanine, arginine, aspartate, cysteine, glutamate, glycine, and proline, followed by sheep milk yoghurt. While Non-Essential Amino Acids (NEAAs) are endogenously synthesized, their requirements often exceed the body's biosynthetic capacity during periods of physiological stress, illness, or rapid growth, rendering them "conditionally essential." Consequently, a deficiency in these amino acids can result in significant health complications, including muscle atrophy, impaired immune function, and growth retardation (Razak *et al.*, 2017).

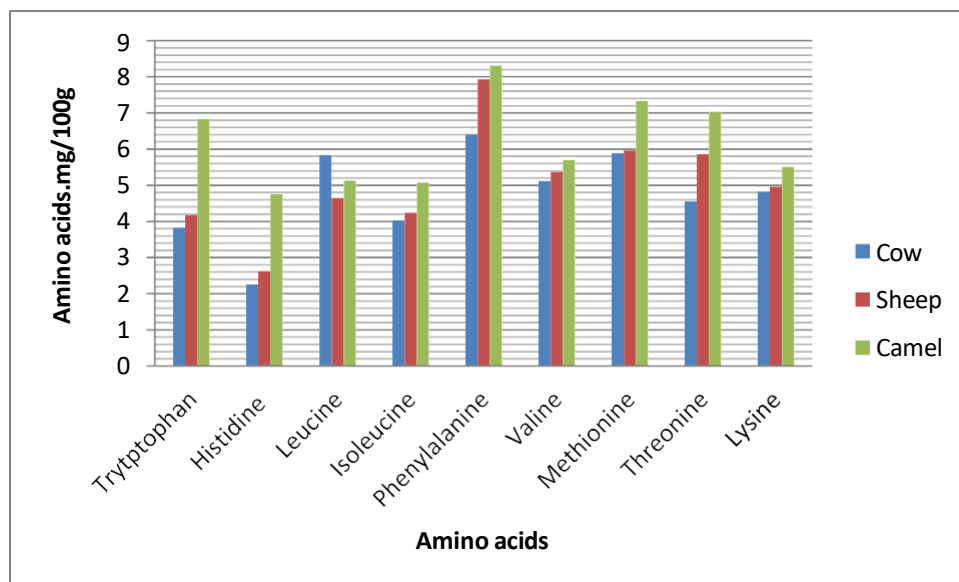


Fig.1: Essential amino acids

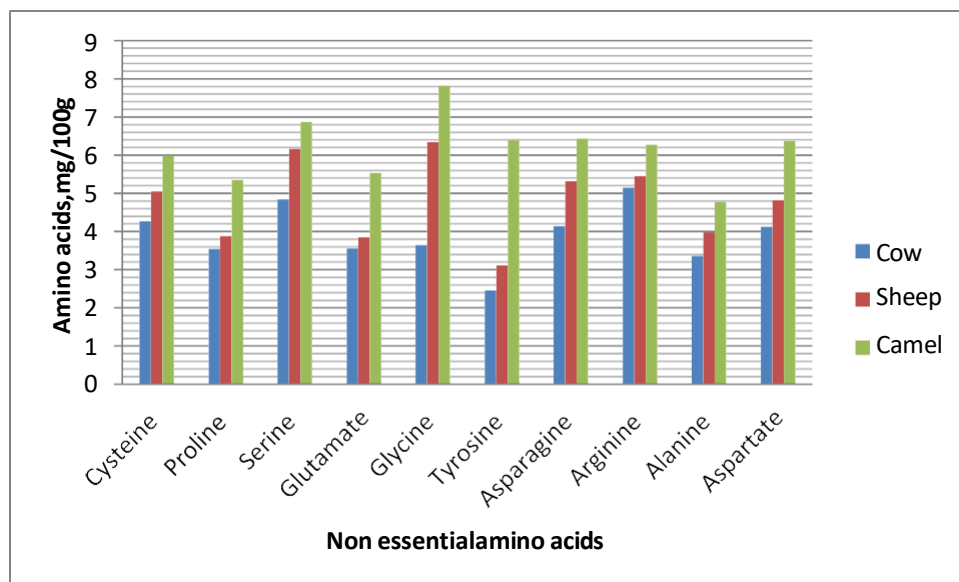


Fig. 2: Non-essential amino acids

Sensory evaluation

Sensory evaluation revealed significant differences ($p < 0.05$) in the organoleptic profiles of yoghurts derived from camel, sheep, and cow milk. Camel milk yoghurt was characterized by lower perceived creaminess, smoothness, and sweetness, while exhibiting higher scores for sourness and a watery consistency. In contrast, sheep milk yoghurt was identified as the most viscous, smooth, and spreadable, possessing a robust yoghurt flavour. Cow milk yoghurt achieved the highest overall acceptability, attributed to its superior flavour profile and the absence of off-flavors. These results suggest that consumer preference is driven by specific textural and flavor requirements: sheep milk yoghurt appeals to those prioritizing creaminess and

structural integrity, while cow milk yoghurt remains the benchmark for flavour intensity and general acceptance. Conversely, camel milk yoghurt may cater to a niche seeking higher acidity and a thinner consistency. These observations align with the findings of Mohamed *et al.* (2021) and Galeboe *et al.* (2018), who noted that camel milk typically yields a softer, less viscous, and smoother—albeit occasionally sandy-texture compared to the firmer, gel-like matrix of cow milk yoghurt. Ultimately, the high overall acceptability scores confirm the continued consumer preference for cow milk-based products. These insights offer valuable data for the dairy industry in tailoring products to meet specific consumer sensory expectations.

Table 2: Sensory attributes of each yogurt produced from cow, sheep, goat and camel milk

Attributes	Camel milk yoghurt	Sheep milk yoghurt	Cow milk yoghurt
Creamy	6.20 ± 0.30c	7.40 ± 0.40b	7.80 ± 0.40b
White	6.80 ± 0.40c	7.20 ± 0.50b	7.60 ± 0.40a
Smooth	6.40 ± 0.30c	7.60 ± 0.40b	7.80 ± 0.40a
Lump	1.80 ± 0.20c	1.20 ± 0.10b	1.00 ± 0.10b
Sour/Acidic	5.60 ± 0.30c	5.20 ± 0.20a	4.80 ± 0.20a
Bitter	2.20 ± 0.20c	1.80 ± 0.10a	1.60 ± 0.10a
Sweet	6.00 ± 0.30c	6.40 ± 0.40b	6.80 ± 0.40a
Spreadable	6.60 ± 0.30c	7.20 ± 0.40a	7.40 ± 0.40a
Spoonable	6.40 ± 0.30c	7.00 ± 0.40a	7.20 ± 0.40a
Yog. flavor	6.20 ± 0.30c	6.80 ± 0.40a	7.00 ± 0.40a
Off-Flavor	1.80 ± 0.20c	1.40 ± 0.10a	1.20 ± 0.10a
Thick	5.80 ± 0.30c	6.60 ± 0.40a	6.80 ± 0.40a
Watery	2.40 ± 0.20c	1.80 ± 0.10a	1.40 ± 0.10a
Acceptability	6.60 ± 0.30c	7.20 ± 0.40a	7.40 ± 0.40a

Table 3: Volatile compounds in yoghurts

Compounds	Camel Yoghurt, %	Sheep Yoghurt, %	Cow yoghurt, %
Hexanol	21.23	12.35	15.01
Linalool	5.34	3.215	6.83
Myrcene	19.23	9.13	14.77
Furan	4.345	2.02	5.12
Furfural	2.925	1.25	3.49
Hexanal	1.78	0.775	0.83
Heptanal	1.875	0.0365	0.926
Octanal	2.39	0.235	4.07
Nonanal	0.34	0.13	0.42
Decanal	2.735	1.225	3.96
2 – Heptanone	1.745	0.653	0.085
Sabinene	0.14	0.0335	0.21
Ocimene	0.088	0.046	0.058
Carene	0.0775	0.0355	0.646
Cymene	0.084	0.0365	0.107
Terpinolene	0.075	0.063	0.081
Perillen	0.0475	0.017	0.032
Terpinyl acetate	0.175	0.037	1.008

Terpeneol	0.085	0.0465	0.097
Piperitone	3.745	1.33	2.84
Carveol	0.032	0.024	0.036
Benzyl alcohol	6.13	3.235	5.453
Guanidineacetic acid	2.15	1.235	1.92
Nonanoic acid	0	0	0.014
Decanoic acid	0	0	0.001
Octanoic acid	0	0	0
Acetic acid	37.235	13.18	19.016
2,5 - Furanone	0	0	0.021
2 – Nonanone	0.0915	0.0655	0.018
2 – Decanone	0.84	0.0235	0.432
Ethyl acetate	1.535	0.76	1.39
Ethyl propionate	1.125	0.79	1.274
Ethyl butyrate	0.72	0.3555	0.852
Ethyl hexanoate	0.0825	3.85	0.931
Limonene	0.325	0.1255	0.427
Pinene	0.125	0.335	0.019
Caryophyllene	0.086	0.046	0.015
2 – Acetyl – 1 – pyrroline	0.0745	0.053	0.138
2 – Ethyl – 3,5 – dimethyl pyrazine	0.0625	0.037	0.041
Ethyl pyrazine	0.034	0.0265	0.009
2,3 - Diethyl – 5 - methyl pyrazine	0.044	0.012	0.123
Ethyl octanoate	13.445	7.23	7.217

Volatile components of yoghurts prepared from sheep and camel milk

The volatile components of yoghurts prepared from camel, sheep and cow milk is presented in Table 3. The research results highlighted significant differences in the chemical composition of camel, sheep and cow yoghurt, particularly in alcohols, aldehydes, acids, esters, and aroma compounds. Yoghurt from cow milk has the highest octanal, nonanal, decanal and furfura while camel milk yoghurt was with the highest composition of furan, hexanal and heptanal. These aldehydes are considered the core compounds for traditional characteristics of yoghurt flavour (Liu *et al.*, 2022). Aldehydes, such as hexanal (fruity, green, fatty), heptanal, and nonanal (sweet, grass-like), contribute to the overall complex flavor profile (Cheng, 2010). Acetaldehyde was not detected and this may be due to esterification reaction in the yoghurt declining acetaldehyde and increasing fruity notes over time (Cheng, 2010).

The ester content also varies and primarily contributes to the fruity, floral, and sweet aromas of yoghurts. The esters identified include ethyl acetate, ethyl propionate, ethyl butyrate, ethyl hexanoate and ethyl octanoate. The ethyl

acetate is noted for pineapple and apple while butanoate give banana flavour (Li *et al.*, 2024). Esters mask undesirable, bitter and stringent flavours in foods which enhance its flavor complexity. Yoghurt from sheep milk has more of ethyl hexanoate more than yoghurts from camel and cow milk (Table 3). The aromatic compounds identified are ethyl pyrazine, 2-acetyl-1-1 pyrroline and benzyl alcohol.

CONCLUSION

Yoghurts produced from diverse milk sources exhibit distinct physico-chemical, amino acids and volatile profiles, catering to varied consumer preferences. The physico-chemical variations observed are primarily attributable to the inherent compositional differences of the raw milk sources. Camel milk yoghurt demonstrated superiority in its amino acid profile, yielding the highest concentrations of key essential and non-essential amino acids, most notably tryptophan, leucine, lysine, and methionine. All yoghurt variants were deemed organoleptically acceptable, cow milk yoghurt maintained the highest consumer preference, largely due to its superior texture and flavor balance. The

volatile profile analysis identified a complex array of compounds, including acids, alcohols, esters, aldehydes, and aromatic compounds, which defined the products' sensory characteristics. Specifically, aldehydes such as hexanal, heptanal, octanal, and decanal, along with esters including ethyl acetate, ethyl propionate, ethyl hexanoate, and ethyl butyrate, were instrumental in shaping the flavor intensity of the yoghurts. Furthermore, the presence of potent aromatic compounds, such as ethyl pyrazine, 2-acetyl-1-pyrroline, and benzyl alcohol, contributed to the unique olfactory signatures of each milk source. These findings provide a technical framework for the dairy industry to develop specialized yoghurt products tailored to specific nutritional and sensory niches.

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