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Nutritional Parameters of Goat Milk and Its Consumption in Rural Communities

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ABSTRACT

A survey was conducted using a pretested, semi-structured questionnaire in Mutoko district to determine the extent of goat milk consumption and reasons for the possible low-to-non-consumption of goat milk. A total of 120 respondents were randomly selected. Fresh goat milk samples were also collected from Mashona and Matabele goat breeds and analysed using a Milko-scan FT 6000 (FOSS, HillerOD, Denmark) to determine nutrient composition. Results from the study indicated that goat milk is lowly utilized – with only 14% of the surveyed households consuming goat milk. The respondents cited that goat milk was lowly utilised because goat milk consumption is traditionally uncommon in the area (57.70%) and has an undesirable strong smell (17.06%). Consuming goat milk was associated with reduced social status (10.66%). Respondents that had access to sufficient cow milk (13.96%) do not consume goat milk. Estimated mean milk yield per goat per milking, as reported in the study was 310.0±114.02 mL. High levels of education were associated with increased tendency to consume goat milk ($\chi 2=246$; df=40, p=0.000). Mashona goat milk had higher lactose (4.36%) and protein (4.77%) but lower fat content (3.45%) than Matabele goat milk. While goat milk is less popular in the study area, the milk from these indigenous goat genotypes is characterised by good nutritional value comparable to the accepted values of good quality milk. The quality of the milk, coupled with feeding and breed selection interventions to increase yield, has potential to be a rich nutrient source for small-holder communities threatened by malnutrition.

Yerli Keçi Sütünün Besin Bileşimi ve Kalitesi ile Kırsal Toplumların Protein Beslenmesine Katkısı

MAKALE BİLGİSİ

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ÖZ

Mevcut çalışmada keçi sütü tüketiminin kapsamı ve keçi sütü tüketiminin yetersiz olma nedenlerinin belirlenmesi amacı ile Mutoko ilçesinde önceden test edilmiş, yarı yapılandırılmış 120 katılımcının yer aldığı bir anket kullanılarak bir anket çalışması yürütülmüştür. Mashona ve Matebele keçi ırklarından taze keçi sütü örnekleri toplanmış ve besin bileşimini belirlemek için bir Milko-scan FT 6000 (FOSS, HillerOD, Danimarka) kullanılarak analiz edilmiştir. Araştırmanın sonuçları, keçi sütü tüketiminin düşük olduğunu ortaya koymuştur.Ankete katılan

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Anahtar Kelimeler

Yerli keçi
Süt kalitesi
Yetersiz beslenme

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hanelerin yalnızca %14'ünde keçi sütü tüketilmektedir. Katılımcılar, bölgede keçi sütü tüketiminin geleneksel olarak yaygın olmaması (%57,70) ve istenmeyen keskin koku (%17,06) nedeniyle keçi sütünün az kullanıldığını belirtmişlerdir. Keçi sütü tüketimi ile sosyal statü arasında bir ilişki tespit edilmiştir (%10.66). Yeterli inek sütüne ulaşabilenler (%13,96) keçi sütü tüketmemektedir. Çalışmada her sağımda keçi başına ortalama süt verimi 310.0±114.02 mL olarak belirlenmiştir. Yüksek eğitim düzeyi, keçi sütü tüketme eğilimi ile ilişkilendirilmiştir ($\chi 2$=246; df=40, p=0.000). Mashona keçi sütü, Matebele keçi sütünden daha yüksek laktoz (%4.36) ve protein (%4.77) ancak daha düşük yağ içeriğine (%3.45) sahip olmuştur. Keçi sütü, çalışma alanında daha az popüler olmakla birlikte, yerli keçi genotiplerinden elde edilen süt, kaliteli sütün kabul edilen değerleri ile karşılaştırılabilir besleme değerine sahiptir. Sütün kalitesi, verimi artırmak için besleme ve ırk seçimi müdahaleleri ile birleştiğind yetersiz beslenme tehdidi altındaki küçük toprak sahibi topluluklar için zengin bir besin kaynağı olma potansiyeline sahiptir.

Introduction

The global goat population is estimated at one billion (FAO, 2018). In Africa, non-descript indigenous goats represent the majority of the goat population and these are owned by resource poor farmers in the rural areas (Ncube et al., 2022). Goats can survive under environmental conditions that are difficult for other domestic livestock species because of their better heat and drought tolerance as well as the ability to survive on limited pastures (Serradilla et al., 2018; Stone et al., 2020; Chebli et al., 2020).

Despite their wide-spread distribution and remarkable merits, goats have often received little attention from various stakeholders. Most smallholder goat keepers suffer high levels of protein undernutrition caused by food insecurity. Undernourishment poses one of the most serious health challenges faced by the world(Sebtiarini et al., 2016). More than 3 billion people could not afford a balanced diet in the year 2020 while about eight hundred people in the world faced undernutrition in 2021(FAO, IFAD, UNICEF, WFP, WHO, 2022). Continentally, Africa has the highest (20.2%) prevalence of undernutrition followed by Asia (9.1%), Latin America and the Caribbean (8.6%) and North America and Europe having the least levels (<2.5%) (FAO, IFAD, UNICEF, WFP and WHO, 2022).

In Zimbabwe, approximately 3 million people faced acute food insecurity (FAO, 2022). This is becauase most marginalised communities cannot afford nutritious foods due to budgetary limitations leading to reduced dietary diversity (Macheka, 2018).

With malnutrition and poverty on the rise, alternative sources of animal protein need to be investigated. The utilization of affordable and available animal protein by the resource poor may help to alleviate the increasingly escalating cases of food insecurity and undernourishment. There has been the possibility of using goats as a potential protein source through milk and chevon. While most communal goat farmers may not afford keeping specialized milk goat breeds because of cost and management needs, they already own hardier indigenous goat genotypes which can be a useful source of meat and milk. Goat milk has been referred to as the most complete nourishing natural and highly compatible food and its nutritional composition is higher than that of bovine milk, except for lactose (Getaneh et al., 2016). Goat milk has been recommended as a substitute for patients allergic to cow milk and have gastro-intestinal disorders (Park, 2017). It has superior digestibility, buffer capacity, alkalinity and therapeutic

significance (Lad et al., 2017). The protein, fat and ash content of goat milk ranges between 27-35, 30-40 and 8.0-8.2, respectively (Zervas and Tsiplakou, 2013). The lactose content of goat milk averages 41g/kg while total solids content ranges between 110 and 135g/kg (Nayil et al., 2022).

There is, thus, a need to quantify the dietary contribution of goat milk in improving nutritional standards of smallholder communal area dwellers. In Zimbabwe, it is estimated that 90% of small-holder communities keep two main indigenous goat breeds namely the Small East African goat also known as the Mashona goat common in the eastern and central areas and the Matabele (Nguni or Ndebele) goat dominant in southern and western Zimbabwe (Sikhosana and Senda, 2010). The Matabele is distinctively larger than the Mashona goat (Sikhosana and Senda, 2010) The Matabele goat genotype has a mature weight that ranges from 35 to 55kg. The average weight of kids at birth is 2.5kg with a weaning weight range between 12 and 16kg. The fertility rate is about 86.6% while twinning is 62% (Zimbabwe Agricultural Growth Programme, 2019a). The Mashona goat breed has a mature weight that ranges between 25 and 35kg. Average birth and weaning weights are 2.4 and 11kg, respectively. Fertility rate is 67.2% and twinning rate ranges from 14 to 30% (Zimbabwe Agricultural Growth Plan, 2019b).

This study aimed to document farmer perceptions on the dietary contribution of goat milk with a view to evaluate its potential as a means to bridging the protein malnutrition gap in such areas. The study would, also, evaluate the nutritional composition of goats indigenous to Zimbabwe that happen to be ubiquitous in most communal households.

Materials and Methods

Study area

Parts of the study were done in Mutoko, Mazowe (Henderson Research Institute) and Chivhu Districts and in Harare (Department of Livestock and Veterinary Services). Mutoko district is located in Mashonaland east province of Zimbabwe. The district is located in natural region (NR) 2a and is characterized by low to less consistent rainfall ranging between 650 and 850 mm and low, inconsistent rainfall ranging between 450 and 650 mm respectively (Mugandani et al., 2012).

Henderson Research Institute is located in Mazowe district, Mashonaland central province of Zimbabwe (Sukume et al., 2015). The district lies in NR 2b. The high altitude areas closer to Harare generally receive higher and more reliable rainfall ranging from 750–1000 mm per annum (Mugandani et al., 2012) compared to the lower altitude areas. The Department of Livestock and Veterinary Services is in Harare, NR 2b with an annual rainfall of 750-1000mm. Chivhu district, on the other hand, is in Mashonaland east province, in NR 3 which is characterised by annual rainfall of 500-750 mm, mid-season dry spells and high temperatures (Mugandani et al., 2012). The areas are characterized by acacia, miombo, *Terminalia Combretaceae as well as Brachystegia* species and *Julbernadia globiflora* trees (Garwe et al., 2009) hence the goats can feed and browse.

Sampling procedure

Mutoko district was chosen because livestock, particularly goat production is amongst the predominant activities since the area is mountainous (for browsing). Goats are hardy and

adaptable to such semi-arid conditions that are prevalent in Mutoko. Goat milk is the subject of concern because it is underutilized and had received little attention from researchers.

Convenience sampling technique was used to select wards on the basis of close proximity to a road network since there are poor road networks in some areas and making the areas inaccessible by public road transport. Additionally, potential consumers of goat milk were the target informants for this study. To determine the sample size for the study, the formula below was used:

$$N = (Z^2pq)/e^2 \text{ (Kothari, 2004),} \quad (1)$$

Where:

N = the desired sample size,

Z = the standard variant at 95% confidence level,

P = 0.5, the proportion in the target population

e = 10%

at 95% confidence interval, z = 1.96 and q = 1-p therefore q = 0.5

$$n = (1.96^2 \times 0.5 \times 0.5)/0.01^2$$

n= 96.04 ~96 and add 10% of the population gives 116 respondents. A total of 120 respondents were interviewed.

Two wards in Mutoko district were selected. From each ward, six villages and from each village ten households were selected. A total of 120 respondents were interviewed. Sampling frames for the wards, villages and households were obtained from the Chief and Mutoko Rural District AGRITEX head officer, Headmen and Village heads, respectively.

Data collection

Data were collected in two stages, firstly a survey on farmer perceptions on goat milk consumption and its contribution to the protein nutrition of the smallholder farming community was conducted. The second stage involved subjecting milk samples to Milko-scan analysis to determine their nutrient composition.

The survey was conducted using a semi-structured, pre-tested questionnaire as the main data collection tool. The questionnaire was used to collect information on demographic details, socio-economic household details, general livestock production, goat production and farmer's perceptions on goat milk consumption. Respondents were informed of the objectives of the study and the researcher requested for informed consent such that only volunteers participated in the study. Key informants - councillors, village heads and the extension workers - were interviewed in a pilot study to improve the quality and reliability of the data obtained in the main study.

In the second stage, milk samples were collected from commercial flocks in Chivhu and Mazowe districts, Zimbabwe. Goats kept by rural communities produced low amounts of milk which could not meet the least amounts required for nutrient profiling hence milk from commercial flocks was used for nutrient analysis. Milk samples from twenty-five goats were collected into vials which were packed in a cooler box filled with ice to keep the milk samples cool and fresh. The milk samples were transported to the Dairy Services Department at the Central Veterinary Laboratories, Harare, Zimbabwe for the analyses of total solids, protein, lactose, ash and fat content using a Milko-scan FT 6000 (FOSS, HillerOD, Denmark). The

machine automatically measures the nutritional composition of milk samples that have a temperature range from 5 to 35^{o}C.

Statistical analyses

Data were analysed by using IBM SPSS ver. 25 (SPSS Inc, 2017). Analysis entailed estimating descriptive statistics and standard measures of dispersion. Chi-square tests were performed on categorical data to check for possible associations among variables. Significance was considered at the 5% level of significance. Graphical representations were done using Sigma Plot ver. 10 (Systat Software Inc, 2006).

Results

Survey results

Demographics and socio-economic details

One hundred and twenty respondents were interviewed and approximately 57% were males. The minimun mean and maximum age of respondents were 20 and 96 years respectively. The majority (62%) of respondents attended secondary school, followed by primary school (34%) with the least group composed of respondents who never attended school and those who attended tertiary education (2%). At least each one active economically active member was reported by the respondents. All respondents stated that their livelihoods were based on either crop or livestock production.

Goat production

Most (72.6%) of the respondents own at least one goat with 66.4% of these goat owners raising their goats under the small-holder herding/shepherding production system while 33.7% tethered them. The Small East African, commonly known as the Mashona goat, was the common ecotype kept in the area. The mean flock size was 6.93 goats per household. The results of the study indicated that the goat herds consisted of more female (5.10%) goats compared to the bucks (1.82%). The flocks had fewer pregnant (1.85%) and lactating goats (0.87%). The mean number of parities was 2.08%.

Approximately 52% of the goat owners were females. The goats were mainly kept for manure (67%) and meat (64%). Other uses of goats were skins/hides (13%), milk (8%) and ritual purposes (6%). Most (30.5%) of the respondents used neither veterinary nor traditional health management, 24.2% used veterinary health services only, 19.4% used a combination of traditional and veterinary medicines while a small proportion applied traditional medicines only (such as *chin'ai/soot*, *zvibweravana*, aloe vera/ *Aloe barbadensis* and ground *mutiti*/ *Erythrina abyssinica* tree bark). The most common factor constraining goat production in Mutoko district was shortage of feed resources (25.3%).

Goat milk

Only 10% of the surveyed goat owners milked their goats. Most (57.7%) of the respondents cited that goat milking and goat milk consumption is an uncommon practice and is the reason why they don't milk the goats and why they also do not consume goat milk. The other reasons for not milking and not consuming goat milk are shown in 'Table 1'. Approximately 14% of the respondents consume goat milk whereby non-goat owners who

prefer goat to cow milk reported that they obtained the milk from friends or relatives. Goat milk is used fresh in tea (9.8%) or fermented and consumed as relish (4.2%). Chi-square test results (d.f=28, $p< 0.01$) indicated a strong relationship between the highest level of education and consumption of goat milk.

Table 1. Reasons cited by communal dwellers in Mutoko district for not milking and consuming goat milk (n=120)
Table 1. Mutoko ilçesi sakinlerinin keçi sütü sağmama ve tüketmeme nedenleri (n=120)

Reason for not milking goats	**Frequency (%)**	**Reason for non-consumption of goat milk**	**Frequency (%)**
Uncommon practice	51.4	Uncommon practice	57.7
Low yield	13.0	Strong/ unpleasant smell	17.1
Have sufficient cow milk	6.7	Allergic	1.6
Embarrassing practice	8.2	Embarrassing practice	10.6
Small udder	10.7	Have sufficient cow milk	13.0

The estimated minimum, mean and maximum milk yield for the Mashona goat genotypes as reported by the respondents in the current study were 200.0±114.02, 310.0±114.02 and 500.0±114.02 mL of milk, respectively. There was irregularity in milking frequency with some of the respondents (4.1%) milking twice a week.

Eighty six percent of the respondents preferred cow to goat milk mostly because it is the milk type they are familiar with. The elder people who preferred goat milk cited its creaminess, especially in tea, as one of its most notable positive attributes. There was a significant association between age of respondent and milk type preference (d.f=47, p=0.001). The younger respondents preferred cow milk to goat milk. Some respondents showed awareness on the nutritional and medicinal attributes of goat milk 'Table 2'. Interestingly, one of the respondents stated that young orphaned children got first priority to goat milk and added that goat milk improved the health status and bone development in young children. Baobab flavoured milk juice (made by fermenting a mixture of raw goat milk and baobab fruit pulp with or without sugar) and sour milk (instantly soured by adding *matunduru* (*Garcinia buchananii)* fruit juice to fresh milk) were the only two products reported in the study.

Table 2. Opinions of the respondents on the medicinal properties of goat's milk (n=120)
Table 2. Ankete katılan kişilerin keçi sütünün tıbbi özellikleri hakkındaki görüşleri (n=120)

Medical condition cured	**Frequency (%)**
Sores on the throat	3.2
Kwashiokor	2.4
Poor bone development	1.6
Eyesight problem	0.8
Coughs	0.8

Nutritional evaluation

Nutritional evaluation results showed that Matabele goat milk had a higher fat and lower protein and lactose content than Mashona goat milk under similar rearing conditions 'Figure 2'. Chi-square tests were performed to check for possible associations between fat, protein and lactose content and place of milk, stage of lactation and the age of doe. The results indicated that there is an association between the nutritional composition milk fat, protein and lactose content and stage of lactation (d.f=16, $p<0.01$).

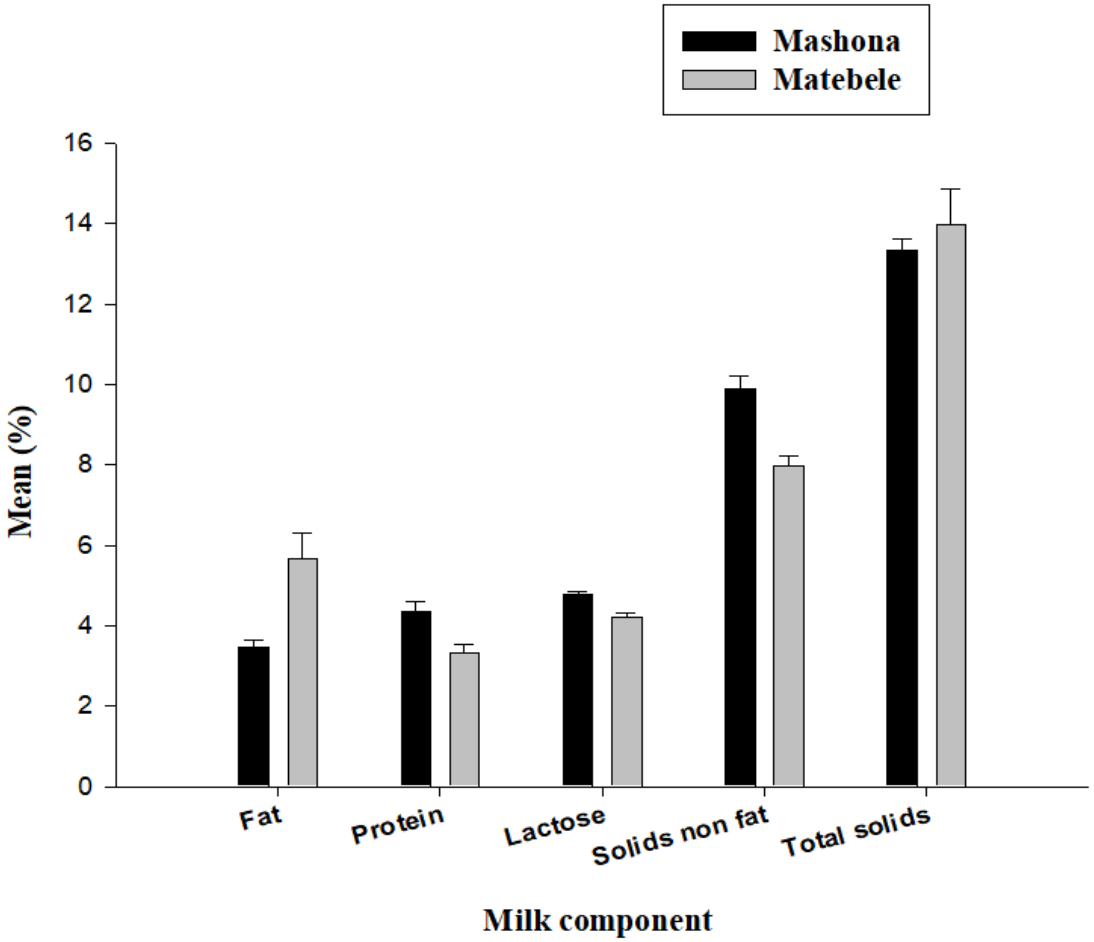

Figure 1. Nutritional composition of milk from Mashona and Matabele goats (n=25)
Şekil 1. Mashona ve Matabele Mashona ve Matabele keçilerinden elde edilen sütün besin bileşimi (n=25)

Discussion

The mean age of respondents observed in this study is consistent with previous similar work (Mhlanga et al., 2018). These researchers reported an average age of 52.4±16.20 years. The reason for the goat ownership patterns observed is that goats are easy to handle and manage hence women and children provide the family labour required for flock management (Gizaw, 2010).

The Mashona goat was the most common breed in the area and this concurs with the report by Sikhosana and Senda (2010) who noted that Mashona goats are common in the eastern areas of Zimbabwe. The finding on shortage of feed resources being a common factor limiting goat productivity is contrary to previous observations. Mhlanga et al. (2018) and Musara et al.

(2013), reported poor health management and lack of organised marketing systems, as the major factors constraining goat production. The herding/ shepherding system, where goats commonly grazed along with cattle, improves the quality of pastures as goats have a higher capacity to valorize low quality forage. They are well adapted to grazing on rangelands and when correctly managed, can protect and enhance forage biodiversity (FAO, 2014).

The fact that level of formal education attained was influenced the consumption of goat milk is logical in that an increase in the level of formal education increases the knowledge and awareness of consumers concerning the features of a product (Kotler and Armstrong, 2010). Awareness on important positive attributes such as medicinal or superior nutritive value of goat milk are, therefore, likely to be considered by the more enlightened individuals. This is consistent with Icoutchika et al. (2022) who noted that an increase in the level of formal education increases the willingness of consumers to purchasegoat milk. On the contrary, Shaharudin et al. (2010) reported that the choice of food is mainly influenced by health consciousness. Consumers' level of education negatively affects consumer behaviour toward goat milk (Utami, 2014) implying that as the level of education increases, the desire to consume goat milk would decrease.

In agreement to earlier observations, being unused to goat milk consumption, strong smell and unavailability of goat milk were the major reasons for non-consumption of goat milk. (FAO, 2017)). This can be attributed to the presence of odor-active (Buettner and Siefarth, 2014) and volatile compounds such as terpenes, hexanol, (E)-2-hexenal and 2-pentanone which imparts rancid and strong fatty odor in raw goat milk (Queiroga et al., 2019). The off-flavour/ unfamiliar taste of goat milk is also influenced by feeds or fodders or silages, weeds, forages, chemicals, building materials, colostrum, estrus, mastitic milk, filthy utensils and strainer, unclean milking equipment and slow cooling (Muhammad et al., 2017). Weeds contain odoriferous benzylthiocianate which cause bad odor in milk and these can be prevented in milk if the weeds are not fed to the lactating goat 5h before milking (Muhammad et al., 2017). In addition, goats survive exclusively on browsing native vegetation. Native vegetation containaromatic compounds such as terpenes which are absorbed from the digestive tract into the blood and udder consequently into the milk (Sant'Ana et al., 2019) resulting in the strong smell. The strong smell can be attributed to the smell of the buck in combination with poor ventilation in milking areas, poor milking procedures (Haenlein, 2004). Mismanagement during cooling of the milk can also cause the eggy flavor of milk (Carter et al., 2022). The `goaty' flavour is preventable through good management, milking healthy lactating does, clean milking procedures and proper ventilation of the milking parlour (Park, 2010).

The milk yield in this study is lower than that of Etawah crossbred, Sapera and Saperong goats in Yogyakarta, Indonesia, which are 1 340.00±76.38, 1 674.00±122.77 and 1 750.70±73.83 mL/head/day, respectively. The yield was, also, lower than the 1 500.00 mL/day reported for Saanen goats (Suranindyah et al., 2018). The average milk yield of specialised goat breeds is 1.45±0.27, 0.75±0.14 and 0.56±0.12 for Saanen, British Alpine and Toggernburg breeds, respectively (Norris et al., 2011). Besides the obvious breed effect, milk yield is influenced by various other factors including feeding, health status, hormones, number of parities, stage of lactation, litter size, season of kidding and age of does at parturition (Ketto et al., 2014).

Another possible reason for the low yield is the infrequent milking observed in this study. Goats milked more frequently throughout lactation show increased milk yield (Salama et al., 2003) and subsequently increasing milking frequency to 4 times for a short time translating to increased lactation yield (Vijayakumar et al., 2017). Increased milking frequency increases cellular activity and mammary growth and results in increased milk yield from udder quarters (Bogucki, 2018). Frequent milk removal from the udder increases , increase mammary cell proliferation and activity,increase stimulation of the mammary gland, which increases blood flow,oxygen tension and nutrient availability and hence increasing milk yield (Wall and McFadden, 2012).

Cow milk was preferred more because respondents were more familiar with it. The results are in agreement with literature reports (Mpofu, 2010; Guney and Ocak, 2013). The choice to accept/ reject a food is influenced by external environments such as the culture, social class, reference groups and families, globalisation, competition, economic as well as political and technological factors (Kotler and Armstrong, 2010). In the current study, goat milk was perceived to symbolize food for people from very low social/ income background and this negatively affected its consumption. Cultural and social beliefs were previously highlighted as the main factors that reduce the consumption of goat milk (Idamokoro et al., 2019; Icoutchika et al., 2022). In many African cultures, cattle are used as a symbol of wealth while goats are stereotyped the 'poor man's cattle and milking goats is regarded as an expression of poverty and shame (Tefera et al., 2004).

The finding that there is an association between age of respondent and milk type preference is consistent with the results of Mpofu (2010) who highlighted that adults mostly consumed goat milk. In contrast, children were the most common consumers of goat milk in Japan (Guney and Ocak, 2013). The results of the current can be attributed to health consciousness of the elder people (Lin and Kuo, 2019). Older people have compromised health issues caused by physiological natural changes that occur in the body with time and goat milk can bridge the consequences caused by aging and also meet their nutritional and medicinal requirements (Jerop et al., 2013). Results of this study also concur with the results of work by Thohari et al. (2012). Consumers preferred goat milk and its product (*kefir*) as they regard this product as being a functional food further indicating the role of health consciousness towards goat milk consumption. The number of young children in a family significantly affected the choice of food (Feng et al., 2009) for the household. There is a positive significant relationship between payment of a premium for goat milk and the number of children in a household who are below the age of 18 years (Jerop, 2012).

A very small proportion of the respondents in the current study were not aware of the medicinal attributes and nutritional attributes of goat milk. This is in agreement to previous observation (Guney and Ocak, 2015; Idamokoro et., 2019) who observed that most rural farmers were not aware of the nutritional attributes of goat milk. In Nigeria, rural farmers identified the nutritional benefits of goat milk hence most of them consumed goat milk and its products (Adewumi et al., 2015).

With regards to milk quality, fat, protein, lactose, dry matter non-fat (DMNF) and density are common measures of this attribute. The values for milk constituents obtained in the current study are comparable to the range of accepted values published earlier (Yangilar, 2013; Claeys et al., 2014). Milk composition in the current study differed between breeds. The

individual differences are attributed to genetic factors (inherited potential) which cause variations between individual animals within and between breeds (Idowu and Adewumi, 2017). Generally, indigenous goat breeds produce much richer milk in terms of percentage nutrient composition but lower yields than their exotic counterparts (Park and Haenlein, 2010). Low milk yield in tropical goat breeds is due to their inherent low genetic potential among other factors like stress resulting from harsh weather and diseases.

Matabele and Mashona goat milk fat content was superior to 3.80 and 3.79% reported by Park (2010) and Arora et al. (2013), respectively. Lower fat contents - 3.27% in Baladi dairy goats milk (El-Tarabay et al., 2018); 3.98% for Nguni, 2.91% for Boer and 4.08 for non-descript goat breeds have been reported (Idamokoro et al., 2017). Fat content in the current study is comparable to 5.62 by Elena et al. (2003). Lower fat content can be attributed to fat depression. Fat depression is common in rumens fed on grain-rich diets which enhance the production of the *trans*-10 fatty acid isomers by ruminal micro-organisms compared to the majority of goats in the current which exclusively feed on natural pastures and browsing.

Mashona goat milk had a higher protein content compared to 2.4% reported by Mpofu (2010), 3. 60% for Baladi goats (El-Tarabany et al., 2018), 3.54, 3.59 and 3.39% in Nguni, Boer and non-descript goat breeds (Idamokoro et al., 2017). Matabele goat milk had lower protein content than) 4.93% for Red Sokoto (Otaru et al., 2011) and 4.05% for Somali goats (Mestawet et al., 2012). The higher protein content from previous studies can be attributed to a combination of factors such as age and other rearing conditions). An increase in energy content of the diet for goats tends to increase nitrogen content of the milk by 0.1-0.2% units (Salah, 2015) and consequently increase the protein content. Water deprivation also reduces milk yield concentrating protein yield. These local adaptable indigenous breeds that tolerate periods of water deprivation tend to produce milk higher protein content.

The milk dry matter non-fat (DMNF) content in the current study was much lower than 11.4% (Alawa and Oji 2008) as well as 11.79 and 13.42% in the wet and dry season, respectively (Midau et al., 2012). This is not surprising since the fat content of milk in the current was high and thus tends to have an inverse relationship with the SNF. Both Mashona and Matabele goat breeds produced milk with lower SNF compared to 10.27 (Otaru et al., 2011), 9.62, 9.48 and 9.23% (Idamokoro et al., 2017) for Red Sokoto, Nguni, Boer and non-descript goat breeds, respectively. The lower SNF content obtained in this study could be a consequence of nutrition. Feeding extra energy to high lactating animals increased SNF by 0.2% units. Dry matter non-fat (DMNF) decrease with an increase in milk yield (Harris and Bachman, 2003).

Matabele goat milk lactose content was comparable to 4.70% reported by Kittivachra et al. (2007), 4.10% by Park (2010) and 4.55% observed by Arora et al. (2013). The Matabele goats used in this study were in milk for about two days and the milk still had remnants of colostrum. The higher lactose content observed for Mashona goat milk in comparison to the 4.10% reported earlier (Park, 2010) can be attributed to age and increase in number of parities as well as the stage of lactation (Nagy et al., 2017). The metabolic activity, secretory capacity, nutrient intake which are useful in milk synthesis increase with increasing animal age (Carnicela et al., 2008).

Both Mashona and Matabele goats produced milk with high total solids content compared to 12.2% reported by Park (2010). This is because Park (2010) reported the total

solids content of specialised dairy goats which are typical high yielders compared to non-specialised Mashona and Matabele goat genotypes which are low milk-yielders. A high milk yield implies a low total solids content due to the negative correlation between the two, however, the magnitude of this relationship varies with breed and number of lactations (Keskin et al., 2004).

Conclusion

Goat milk consumption in the study area was very low mainly due to the negative perception and unpleasant taste associated with goat milk. The milk was less preferred to cow milk mostly because the respondents are more familiar with cow milk. The indigenous goat breeds studied produce milk of high nutritional value which is comparable to milk from specialised dairy goats, albeit in low volumes, and could be a rich nutrient source for small-holder communities.

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