**Agriculture and Food Sciences Research**
**ISSN: 2411-6653**
***Vol. 3, No. 1, 19-24, 2016***
*http://www.asianonlinejournals.com/index.php/AESR*

# Comparison of Some Quality Characteristics of Milk from White Fulani Cow, Ouda Ewe, and Kano Brown Doe Reared Under the Same Environment

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## Abstract

This study was carried out on three lactating animal species namely: Ouda ewe (A), White Fulani cow (B), and Kano Brown doe (C), at the middle of their second lactation period or parity. The purpose was to compare the gross chemical composition (ash, moisture, total solids, protein, fat, lactose, calcium, pH and titratable acidity) as well as the calorific value of the fresh milk from the three species reared under the same environment. The components were determined using standard analytical methods while the lactose contents were determined by difference. The Ouda ewe milk recorded significantly higher (P□0.05) levels of ash (0.77□0.21%), total solids (19.31□0.17%), protein (4.38□0.04%), lactose (5.36□0.59%), calcium (182.33±0.22mg/100g, and calorific value (88.01±1.22 Cal/100g); and significantly lower (P□0.05) level of moisture (84.04□1.64%) than the White Fulani cow and Kano Brown doe milks. And the lowest levels of pH (6.78□0.06) and titratable acidity (0.22□0.03%) were recorded in the White Fulani cow milk. The results were in agreement with those obtained elsewhere around the world and, it was recommended that efforts should be intensified in creating awareness in Nigeria about the higher nutritional profile of milk from small ruminants and towards breeding of more lactogenic ewe.

**Keywords:** Calorific value, Titratable acidity, Ouda ewe, Kano brown doe, White Fulani cow, Lactogenic.

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**Citation** | Hauwa L. Yusuf; Amin O. Igwegbe; Paul Y. Idakwo (2016). Comparison of Some Quality Characteristics of Milk from White Fulani Cow, Ouda Ewe, and Kano Brown Doe Reared Under the Same Environment. Agriculture and Food Sciences Research, 3(1): 19-24.

**DOI:** 10.20448/journal.512/2016.3.1/512.1.19.24
**ISSN(E) :** 2411-6653
**ISSN(P) :** 2411-6653

**Contribution/Acknowledgement:** All authors contributed to the conception and design of the study. The Authors are very grateful to the Managements of the Department of Animal Science, Faculty of Agriculture, Bayero University, Kano; and the Department of Food Science and Technology, Faculty of Engineering, University of Maiduguri, for providing the facilities and the enabling environment to carry out this study.
**Funding:** This study received no specific financial support.
**Competing Interests:** The authors declare that they have no conflict of interests.
**Transparency:** The authors confirm that the manuscript is an honest, accurate, and transparent account of the study was reported; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained.
**History:** **Received:** 11 March 2016/ **Revised:** 30 March 2016/ **Accepted:** 5 April 2016/ **Published:** 12 April 2016
**Ethical:** This study follows all ethical practices during writing.
**Publisher:** Asian Online Journal Publishing Group

# 1. Introduction

Milk is an important source of all basic nutrients for mammals. Milk from various ruminants is used for producing different dairy products including milk cream, butter, yoghurt, sour milk, etc. [1-3]. Nigeria is the largest milk producer in West Africa and the third largest producer of cow milk in Africa, yet Africa contributes just over two percent of the World's milk supply [4, 5]. Milk accounts for twenty to twenty-five percent of the agricultural sector in Sub-Saharan Africa, two percent of its calories, thirty-three percent of its calcium, and four percent of protein for its people. By value, livestock products make up to eleven percent of the food. The cattle had been the main source of milk in Nigeria for a very long time [6] providing more than 90% of the total annual domestic milk output; with the White Fulani cow or 'Bunaji' breed recognized as the principal milk producer [7]. Unfortunately, the domestic output of about 407,000 metric tonnes of milk [8] from an estimated 14 million cattle can hardly satisfy the dairy demands of an ever increasing population of Nigerians [9].

Local sheep and goat breeds in Nigeria have the potential to supply a significant portion of the milk deficit in the country, because their numbers far exceed that of cattle in both rural and urban communities [9, 10]. Sheep milk can be used in every way that cow's milk is used: over cereal, cooking, baking, and desserts. The taste is often preferred over cow's milk bland taste. It has been observed that after drinking the sheep milk, many people often conclude that cow's milk is "tasteless" whereas sheep milk is sweet and creamy. Sheep milk is also comparable to goat's milk, though the sheep milk does not have the faint bitterness or tanginess of goat's milk, which makes it a more preferable alternative to milk from other animal species [11-13]. Results of various studies have shown that significant percentage of the world's population are lactose intolerant, having difficulty in digesting cow's milk (due to deficiency in lactase enzyme) causing symptoms such as gas, cramp and diarrhea. However, most people with lactose intolerance have been reported to be able to drink and enjoy sheep and goat milks without the symptoms because the milk from particularly the goat, is low in lactose content [14-21]. The fats in sheep and goat milks are both monounsaturated and polyunsaturated; they contain higher proportion of short- and medium-chain fatty acids, which have recognized health benefits. For example, short-chain fatty acids have little effects on cholesterol levels in people. They also make milk easier to digest [22]. Sheep milk is also higher in calcium, as well as containing higher amounts of vitamins A, D, and E. It also offers more essential minerals such as zinc and magnesium [23]. On the other hand, the fat globules in goat milk are known to be smaller in size than those of the cow milk, and consequently, the fat remains suspended (little cream rose to the top) in goat milk as compared with the cow milk when the samples of the two milks were stored at low temperatures [10]. Thus, goat milk is naturally homogenized and therefore it is easier to digest than cow milk because of smaller nature of the fat globules [24].

Although the mineral contents of the goat and cow milks are generally similar, goat milk has been reported to contain 13% more calcium, 25% more vitamin B6, 47% more vitamin A, 134% more potassium, and three times more niacin than cow milk [25-27]. It is also four times higher in copper. Goat milk also contains 27 percent more of the antioxidant selenium than cow milk [28]. Furthermore, cow milk contains five times as much vitamin B12 as goat milk and ten times as much folic acid (12 μg in cow milk versus 1 μg in goat milk per eight ounces with a recommended daily allowance (RDA) of 75-100 μg for children [23, 28]. Like cow milk, goat milk is low in essential fatty acids, because goats also have EFA-destroying bacteria in their ruminant stomachs. Despite that, goat milk is reported to contain more of the essential fatty acids linoleic and arachedonic acids, in addition to a higher proportion of short-chain and medium-chain fatty acids. These are easier for intestinal enzymes to digest [13, 16, 17, 29].

Goat milk protein forms a softer curd — the term given to the protein clumps that are formed by the action of the intestinal acid on the protein [30] which makes the protein more easily and rapidly digestible. Theoretically, this more rapid transit through the stomach could be an advantage to infants and children who regurgitate cow milk easily. Goat milk may also have advantages when it comes to allergies. Goat milk has been observed to contain only trace amounts of an allergenic casein protein, alpha-S1, found in cow milk [1, 30].

In Nigeria, poor nutrition [31] and low reproductive performance have been highlighted as some of the major factors affecting milk production and quality from our indigenous ruminants. Consumers always demand nutritionally rich milk and dairy products provided only from cow milk [8]. In addition, the current processes of milk collection from a large number of subsistence farmers is time consuming, inadequate, costly, and prone to adulteration. Above all, milk collection is limited to cattle, with milk from other sources being uncommon. There is need to investigate the chemical characteristics of milk from some common milk producing ruminants such as the white Fulani cow, the Kano brown goat, and the *Ouda ewe*. There is also the need to check on the possibility of including Kano brown doe milk and *Ouda ewe* milk as alternative sources of milk for regular consumption. The present study was therefore designed to compare the chemical composition and calorific values of the fresh milk from the three animal species. This information is necessary to developing optimal breeding conditions and marketing strategies for both the meat and milk production programmes using these animals which are in abundant supplies in the area.

# 2. Materials and Method

## 2.1. Selection of the Lactating Animals

Five (5) each of the three healthy animal species *Ouda ewe* (A), *white Fulani cow* (B), and *Kano brown ewe* (C), were randomly selected at the middle of their second lactation or parturition period. This is due to the fact that age and stage of lactation play important role in both the quality and quantity of milk from various lactating animals [12, 32]. The animals were confined under one good farm condition in the Animal Science Farm, Faculty of Agriculture, Bayero University, Kano; and were fed with concentrated feeds consisting of grains, seeds and dry fodders. Drinking water was also given to the animals on regular basis.

### 2.2. Samples Collection

The five lactating animals from each group were milked manually (hand milking) twice a day (in the morning and evening) for five consecutive days, and their respective milk was pooled before sampling for the individual component analyses. Samples were stored below the temperature of $5^0$C and the gross chemical analyses was conducted within twelve hours from the last day of sample collections. Approximately 100ml of milk sample was collected from each of the pools in previously sterilized sample bottles, and then transferred to the Animal Science Laboratory in iced coolers, for the analyses.

### 2.3. Chemical Analysis

The fresh milk samples were analyzed for the following parameters: ash, total solids (TS), protein, moisture fat and lactose; in addition to the measurement of the pH and titratable acidity (TA), in accordance with the procedures outlined in Atherton and Newlander [33]; AOAC [34] and Nielson [35]. Protein was determined through the quantification of the nitrogen content by the standard Micro-Kjeldahl methods [34] and Nielson [35] and multiplying the total nitrogen obtained by a conversion factor of 6.38 to arrive at the protein content. The ash content was determined following the procedures described by Al-Wabel [27] and Igwegbe, et al. [36] and while the calcium content in the ash was quantified using a Buck 205 Atomic Absorption Spectrophotometer (AAS, Buck Scientific Inc., USA). Fat content was determined by Gerber method [33, 34]. The moisture determination was carried out by step-up oven drying of five (5) ml of fresh milk at $115^0$C until a constant weight was obtained. The lactose content was obtained by subtracting the sum of protein, fat, ash and moisture from 100 [10]. The pH was measured with a pH meter (Model WTW410D8120, Welheim, German), while the titratable acidity was determined by titration of 9 ml of the fresh milk with 0.1NNaOH in the presence of phenolphthalein indicator [33]. All determinations were carried out in triplicates.

### 2.4. Calculation of the Calorific Values of Milk from the Three Species

Calorific (or energy) values of the milk samples (A, B, and C) were calculated from the results of the chemical analysis, using the following generalized equation [37]:

Cal /100g of milk = (% protein × 4) + (% fat × 9) + (% lactose × 4).

### 2.5. Statistical Analysis

Data were analyzed through analysis of variance (ANOVA). Test for significant differences between means were determined using Duncan‟s Multiple Range Test [38, 39] at 5% level of significance.

## 3. Results and Discussion

Milk can be obtained from all mammals. The first milk produced by mammals after the birth of an offspring looks different and has different composition. It is called colostrum or immature milk [14, 32]. After about 72 hours, a transition to white milk occurs and it is called mature milk. The results obtained from the chemical analyses of the fresh milk samples from the three animal sources are presented in Table 1, along with their statistical parameters. The constituents varied in amount from one species of the animals to another, though the variations are not significant between some of the components. An interesting phenomenon that has been observed in Nature is the relationship between the composition of milks among various mammalian species and the growth rate of the respective offspring. Nature is, perhaps through evolution, conservative and designs the milk of a given species specifically for growth and development of the offspring of that particular species. This extraordinary wisdom and conservation of energy by Nature are demonstrated by and can be appreciated through a close observation of the data presented in Table 1. Note the relatively higher percentages of ash (0.77±0.21%), protein (4.38±0.04%), fat (5.45±0.06%) and lactose (5.36±0.59%) in the *Ouda ewe* milk (A) compared with the milks of White Fulani cow (B) and Kano Brown doe (C), which are recorded as 0.68±0.04%, 3.70±0.01%, 3.54±0.03%, 4.88±0.03% and 0.67±0.02%, 2.64±0.10%, 4.75±0.07% and 4.49±0.21%, for ash, protein, fat and lactose, respectively. Consequently, the calorific value of the sheep milk was observed in this study to be significantly higher than that of goat and cow milks — calculated to be 71.60±0.79, 70.27±1.05 and 88.01±1.22 cal / 100g of goat, cow and sheep milks, respectively. Consequently, it has been reported that the growth rate (time in days for the newborn to double its birth weight) among the offspring of sheep is higher than that of the goat and cow due to the higher concentration of nutrients, particularly protein and ash, the nutrients required to develop muscle and skeleton, in the sheep milk [11, 19, 25, 40]. The result of this study also shows the sheep milk (A) to have significantly higher ($p \leq 0.05$) total solid (TS) contents than the cow (B) and goat (C) milks; and that the TS contents of the goat milk was slightly higher than that of the cow milk (Table 1).

Also, the value of ash recorded in sample A (Ouda ewe), was significantly higher ($p \leq 0.05$) than the values recorded for samples B (White Fulani cow) and C (Kano Brown doe). The values were, however, in agreement with those obtained by Asif and Sumaira [12] for sheep, cow, and goat milks. Moreover, the values are remarkably lower than those observed in a similar study in Malawi by Banda, et al. [41] who recorded 0.88% and 0.94% ash in goat and sheep milks, respectively.

As indicated above, the total solid values recorded in this study was highest ($p \leq 0.05$) in Ouda sheep (19.31%) followed by Kano Brown doe (13.30%), while the lowest percent total solid (12.35%) was obtained from the White Fulani cow milk. The TS content in Kano Brown doe recorded in this study is slightly higher than the value obtained by Igwegbe, et al. [10] while the value from the White Fulani cow milk was significantly lower than that obtained from cow milk in a similar study — the values were 13.17% and 13.80% from goat and cow milks, respectively, from the North eastern part of Nigeria. The higher levels of TS in sheep and goat milks may be attributed to the greater concentration of nutrients in their milks. The higher concentrations of TS in sheep and goat milks have also been observed in various studies by many other researchers [12, 13, 25, 40].

**Table-1.** Comparison between the chemical composition of fresh milk of *Ouda ewe, White Fulani* Cow and Kano Brown doe[1]

| Parameters (%) | Type of Animal[2] | | |
|---|---|---|---|
| | **A (*Ouda ewe*)** | **B (White Fulani)** | **C (Kano Brown doe)** |
| Ash | 0.77 ± 0.21[a] | 0.68 ± 0.04[b] | 0.67 ± 0.02[b] |
| Total solid | 19.31 ± 0.17[b] | 13.35 ± 0.13[c] | 13.30 ± 0.14[c] |
| Moisture | 84.04 ± 1.64[a] | 87.20 ± 0.60[b] | 87.45 ± 1.43[c] |
| Protein | 4.38 ± 0.04[c] | 3.35 ± 0.01[d] | 2.64 ± 0.10[e] |
| Fat | 5.45 ± 0.06[a] | 3.54 ± 0.03[b] | 4.75 ± 0.07[c] |
| Lactose[3] | 5.36 ± 0.59[c] | 5.23 ± 0.03[d] | 4.49 ± 0.21[e] |
| Titratable acidity | 0.35 ± 0.01[b] | 0.22 ± 0.03[c] | 0.40 ± 0.04[b] |
| pH | 6.81 ± 0.02[a] | 6.78 ± 0.06[a] | 6.81 ± 0.03[a] |
| Calcium (mg/100g) | 182.33 ± 0.22[a] | 115.56 ± 0.22[b] | 125.07 ±1.06[c] |
| Calorific value(Cal/100g) | 88.01 ± 1.22[b] | 70.60 ± 0.79[c] | 71.27 ± 1.05[d] |

[1]Values are means of three determinations ± Standard deviation (SD)
[2]In any row, means bearing similar superscripts are not significantly different (p>0.05)
[3]Lactose was determined by difference

With regards to protein, fat, lactose, moisture and mineral (particularly calcium) contents of the milk from the three species investigated in this study, significantly higher (P≤0.05) percentages of protein (4.38±0.04), fat (5.45±0.06), lactose (5.26±0.59) and calcium (182.33±0.22mg/100g) were recorded from Ouda ewe (Table 1) than the values recorded from the White Fulani cow and Kano Brown doe milks. The mean percentage values of protein and lactose were significantly higher (P≤0.05) in White Fulani cow milk (3.35±0.01 and 4.88±0.03) than in Kano Brown doe milk (2.64±0.01 and 4.49±0.21), respectively; while the latter has significantly higher percentage of fat (4.75±0.07) than the former. The higher protein content in sheep milk compared to the other livestock species may be due to the fact that more protein is required for wool development in the lamb. The moisture contents were observed to be inversely related with the percent concentration of other macro nutrients, especially protein and lactose, and thus, the Kano Brown doe milk recorded the highest mean percent level of moisture (87.45±1.43) than the White Fulani cow and Ouda sheep milks (87.20±0.60 and 84.04±1.64), respectively. Also, the doe milk recorded significantly higher (P≤0.05) concentration of calcium (125.07±1.06mg/100g) than the cow milk (115.56±0.22mg/100g). These observations are in collaboration with the results of similar studies around the globe — including those of Banda, et al. [41]; Soliman [26]; Asif and Sumaira [12] and Salman, et al. [37]. Moreover, the levels of fat (7.0% and 6.7%) reported in sheep milk by George [42] and Kolesnikov [21] respectively, are in complete disagreement with the percent fat (5.45±0.08) observed in sheep milk in the present study.

In terms of the pH of the fresh milk, the mean pH of the doe and ewe milks were 6.81 and 6.78, respectively. Although, the titratatble acidity (TA) expressed as percent lactic acid (LA), was observed to be lowest in the cow milk (0.22±0.03), the TA of the fresh milks from the three animal species were within the range obtainable from good quality fresh milk suitable for the processing of any dairy products. The production of acid in milk is normally termed "souring" and the sour taste of such milk is due to lactic acid. The TA of fresh milk is a rough indication of the microbial activity in the milk and the manner in which the milk has been handled; and the hygienic condition of the environment, utensils, freedom from colostrum, prompt cooling of milk after milking and transportation of milk under refrigerated temperature, are the most important factors that determine the level of acidity and suitability of the milk for heat treatment and its use in preparation of dairy products such as yoghurt [10, 43].

Generally, the females of all mammal species can by definition produce milk, but cow's milk dominates commercial production. In 2011, the Food and Agricultural Organization (FAO) estimated that 85% of milk worldwide was produced from cows [4, 5]. The report also indicated that aside from cattle, many kinds of livestock including goat, sheep, camel, donkey, horse, reindeer and yak, provided milk used by humans; and that goat, sheep, camel and donkey produced about 11%, 2%, 1.4% and 0.2%, respectively, of all milk produced globally in 2011. The main constituents of all milks are water, fat, protein, lactose and ash. The constituents other than the water are known as the total solids (TS) and the total solids minus the fat are known as solids-not-fat (SNF) [33]. The composition of normal milk from all the animal species varies to a great extent, but the results from many studies on normal whole milk correspond closely to the figures obtained in the present study. Many factors have been reported to affect the overall composition of milk positively or negatively. These factors include: type or species of the animal, the health condition of the animal (presence or absence of mastitis); stage of lactation; season of the year; type of feed, and to a lesser extent, some constituents — particularly fat, is affected by the time and milking frequency [7, 11, 12, 30, 32].

From the nutritional point of view, sheep milk is highly nutritious, containing more calcium and other minerals as well as vitamins (such as vitamin A, B, and E) than the goat and cow milks. Both sheep and goat milks are more easily digested due to their smaller fat globules. And from the technological aspect, the sheep milk has higher solids content than goat or cow milk. As a result, more cheese can be produced from a liter of sheep milk than a liter of goat or cow milk. In fact, cheese yield of up to 18 to 25% from sheep milk compared with 9 to 10% from cow or goat milks, has been reported; and that freezing of the sheep milk did not affect the cheese-making qualities of the milk. Goat is also termed as walking refrigerator for the storage of milk and can be milked a number of times in a day as compared with twice per day for sheep and cows [44]. Moreover, because sheep usually produce far less milk than goats and cows, sheep milk was observed during the course of this study, to sell for a significantly higher price per liter than that of goat and cow milks. Thus, a serious breeding programme is required to raise more milk-producing sheep particularly in the arid conditions common in the northern part of Nigeria.

## 4. Conclusion

In conclusion, this study has ascertained that the milk of all mammals has similar chemical composition that varies somewhat in the proportion of the constituents from one species to another. The Ouda ewe investigated in this

study appeared to produce the richest milk from compositional point of view, as the milk is characterized by higher total solids, fat, protein, calcium, and ash, than the milk from the White Fulani cow and Kano Brown doe. This finding is in consistent with those of similar studies in various parts of the globe. Efforts should be intensified in creating awareness among the Nigerian populace concerning the higher nutritional benefits that can be derived from the sheep and goat milks.

## References


[1] J. Barlowska, M. Szwajkowska, Z. L. Nczuk, and J. Krol, "Nutritional value and technological suitability of milk from various animal species used for dairy production," *Compreh. Rev. Food Sci. Food Safety*, vol. 10, pp. 291-302, 2011.

[2] A. Ahmad and A. Hassabo, "Milk adulteration by adding water and starch in Khartoum state," *Pak. J. Nutr.*, vol. 8, pp. 439-440, 2009.

[3] I. E. M. El-Zubeir, M. A. E. Basher, M. H. Alameen, M. A. S. Mohammed, and E. S. Shuiep, "The processing properties, chemical characteristics and acceptability of yoghurt made from non-bovine milks," *Lives. Res. Rural Dev.*, vol. 24, 2012.

[4] FAOSTAT, *Yield data: Cow milk, whole and fresh*. Rome, Italy: Food and Agriculture Organization of the United Nation, 2010.

[5] Food and Agriculture Organization FAO, *World dairy cow numbers*. Rome, Italy: FAO, 2011.

[6] M. J. A. Walshe, C. N. Grindle, and M. Benchman, "Dairy development in Sub-Sahara Africa." World Bank Tech. Paper, No.135. Africa Tech. Dept. Service, 1991.

[7] J. A. Adeneye, "Variation in yield and composition of milk from different quarters of lactating white fulani cattle in a tropical environment," *Nig. J. Anim. Prod.*, vol. 16, pp. 8-15, 1989.

[8] E. A. Olaloku, *Problems and possibilities for milk production. In: Animal production in the tropics*. Ibadan, Nigeria: Ibadan Press, 1999.

[9] R.I.M., *Resources inventory and management*. Abuja, Nigeria: Federal Dept. of Livestock and Pest Control Services, 1992.

[10] A. O. Igwegbe, F. J. Maina, A. L. Kassum, G. I. Agbara, E. C. Chibuzo, and M. H. Badau, "Evaluation and acceptability of yoghurt drink processed from goat milk and a combination of goat and cow milks," *Intl. J. Biotech. Food Sci.*, vol. 3, pp. 41-48, 2015.

[11] S. Economides, "Comparative studies of sheep and goats: Milk yield and composition and growth rate of lambs and kids," *J. Agric. Sci.*, vol. 106, pp. 477 – 484, 1986.

[12] M. Asif and U. Sumaira, "A comparative study on the physicochemical parameters of milk samples collected from buffalo, cow, goat and sheep," *Pak. J. Nutr.*, vol. 9, pp. 1192-1197, 2010.

[13] A. Mahmood and U. Sumaira, "A comparative study on the physico-chemical parameters of milk samples collected from buffalo, cow, goat and sheep of Gujrat, Pakistan," *Pak. J. Nut.*, vol. 9, pp. 1192-1197, 2010.

[14] J. R. Campbell and R. T. Marshall, *Dairy goats. In the science of providing milk for mankind*. London: McGraw Hill Book Co, 1975.

[15] D. J. Castro, "Milk is more beneficial to health than cows milk: Study suggests," in *Science Daily, Your Source for the Latest Research News, July 31*, ed, 2007.

[16] G. F. W. Haenlein, "Role of goat meat and milk in human nutrition," presented at the Fifth Int. National Conference on Goats, New Delhi, India, 1992.

[17] G. F. W. Haenlein, "Goat milk in human nutrition," *Elsevier Small Ruminant Res.*, vol. 51, pp. 155-163, 2004.

[18] C. Linda, M. Hale, and W. Paul, "Dairy goats: Sustainable production. Livestock production guide." Available www.attra.ncat.org. [Accessed 29/03/2012], pp. 1-31, 2004.

[19] J. Henriksen, *Milk for health and wealth*. Rome, Italy: FAO Diversification Booklet, Series 6, 2009.

[20] S. Basnet, M. Schneidder, A. Gazit, G. Mander, and A. Doctor, "Fresh goat's milk for infants: Myths and realities ¾ review," *Pediatrics*, vol. 125, pp. 973 – 977, 2010.

[21] V. Kolesnikov, *Beverages and health: Health benefits of sheep milk*. USA: An Educational Website Media, 2015.

[22] L. D. Whigham, A. C. Watras, and D. A. Schoeller, "Efficacy of conjugated linoleic acid for reducing fat mass: A met-analysis in humans," *Am. J. Clinic. Nutr.*, vol. 85, pp. 1203 -1211, 2007.

[23] J. Halliday, *The healthy potential of sheep's milk*. USA: Newsletter Published by William Reed Business Media, 2006.

[24] R. Attaie and R. L. Richter, "Size distribution of fat globules in goat milk," *J. Dairy Sci.*, vol. 83, pp. 940–944, 2000.

[25] R. Kanwal, T. and B. Mirza, "Comparative analysis of quality of milk collected from buffalo, cow, goat and sheep of Rawalpindi/Islamabad region in Pakistan," *Asian J. Plant Sci.*, vol. 3, pp. 300-305, 2004.

[26] G. Z. A. Soliman, "Comparison of chemical and mineral content of milk from human, cow, buffalo, camel and goat in Egypt," *J. Hosp. Med.*, vol. 21, pp. 116–130, 2005.

[27] N. A. Al-Wabel, "Mineral contents of milk of cattle, camels, goats and sheep in the central region of Saudi Arabia," *Asian J. Biochem.*, vol. 3, pp. 373–375, 2008.

[28] C. Thomas, *Benefits of goat milk versus cow milk. In: The high road to health*. Centralia/Chehalis, WA: University of Mt. Capra, 2010.

[29] M. Hadjipanayiotou, "Composition of ewe, goat and cow milk and of colostrum of ewes and goats," *Small Ruminant Research*, vol. 18, pp. 255–262, 1995.

[30] S. Bornaz, A. Sahli, A. Attalah, and H. Attia, "Physicochemical characteristics and renneting properties of camels milk: A comparison with goats, ewes and cows milks," *Intl. J. Dairy Technol.*, vol. 62, pp. 505–513, 2009.

[31] A. A. Adegbola, "Nutrient intake, digestibility and rumen metabolites in bulls fed rice straw with or without supplements," *Nig. J. Anim. Prod.*, vol. 29, pp. 40-46, 2002.

[32] S. C. Nickerson, *Milk production: Factors affecting milk composition. In milk quality F. Harding (Ed)*. London, UK: Chapman and Hall, 1995.

[33] H. V. Atherton and J. A. Newlander, *Chemistry and testing of dairy products*, 4th ed. Westport, Conn: Avi Pub. Co., Inc, 1981.

[34] AOAC, *Official methods of analysis*. Washington D. C. USA: Association of Official Analytical Chemists, 2000.

[35] S. S. Nielson, *Introduction to chemical analysis of foods*. Boston / London: Jones and Bartlett Publishers, 2010.

[36] A. O. Igwegbe, C. H. Agukwe, and C. A. Negbenebor, "A survey of heavy metal (Lead, Cadmium and Copper) contents of selected fruit and vegetable crops from Borno State of Nigeria," *Intnl. J. Engr. Sci.*, vol. 2, pp. 1 – 5, 2013.

[37] M. Salman, M. Khaskheli, Israr-ul-Haq, and A. A. Tal, "Comparative studies on nutritive quality of buffalo and cow milks. Impact," *Intl. J. Res. Applied Nat. Soc. Sci.*, vol. 2, pp. 69-78, 2014.

[38] D. C. Montgomery, *Design and analysis of experiments*. USA: John Wiley and Sons, Inc, 1976.

[39] R. Mead, R. N. Curnow, and A. M. Hasted, *Statistical methods in agriculture and experimental biology*, 2nd ed. London, UK: Chapman and Hall, 1993.

[40] T. M. P. Cattaneo, F. Nigro, and G. F. Greppi, "Analysis of cow, goat and ewe milk mixtures by capillary zone electrophoresis (CZE): Preliminary approach," *Milchwissenschaft*, vol. 51, pp. 616–619, 1996.

[41] J. W. Banda, J. Steinbach, and H. P. Zerfas, "Composition and yield of milk from none-dairy goats and sheep in Malawi. In small ruminant research and development in Africa," in *Proceedings of the First Biennial Conference of the African Small Ruminant Research Network. Nairobi, Kenya, 10-14 Dec., 1990*, 1992.

[42] F. W. H. George, "The nutritional value of sheep milk." Available from www.sheep101.info/dairy.html. [Assessed 25/8/15, 2014], 2014.

[43] T. R. Fenton and A. W. Lyon, "Milk and acid-base balance: Proposed hypothesis versus scientific evidence," *J. Am. Coll. Nutr.*, vol. 30, pp. 471-475, 2011.

[44] A. Grandison, "Causes of variation in milk composition and their effects on coagulation and cheese making," *Dairy Ind. Intl.*, vol. 51, pp. 21-24, 1986.

## Bibliography

[1] M. Borkova and J. Snaselvo, "Possibilities of different animal milk detection in milk dairy products ¾ a review," Czech. J. Food Sci., vol. 23, pp. 41 – 50, 2005.