

Quality evaluation of sheep, goat and camel milk using laser technique

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Abstract: Spectroscopy at visible wavelength is one of the modern trends and techniques. In this study, the physicochemical quality of sheep, goat and camel milk samples from Halayeb and Shalateen area in Egypt was evaluated using laser technology. The qualification was done by laser technique with optical properties (reflection, absorption) with wavelength 632.8 nm. The conclusion can be summarized in the following points: (a) Total solids and pH in milk have been measured in terms of % of lactic acid, and order in different samples of milk is obtained as: sheep milk < goat milk < camel milk, (b) Fat, protein, ash, and total carbohydrate content determined in various samples of milk have been reported, and order in different samples of milk is obtained as: sheep milk > goat milk > camel milk, (c) There is direct proportion between Laser reflection percentage and pH value while there is inverse proportion between Laser reflection percentage and total solids, fat, protein, ash and carbohydrate percentage. Also, there is inverse proportion between Laser absorption percentage and pH value. While there is direct proportion between the Laser absorption percentage and the total solids, fat, protein, ash and carbohydrate percentages, and (d) Laser techniques applied are available, fast, and easy used to detect milk quality.

Keywords: Laser, sheep milk, goat milk, camel milk, physico-chemical properties analysis, milk quality.

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1 Introduction

Milk, a complex colloidal system, includes fat globules, casein micelles, and whey proteins within lactose, minerals, and other minor compounds

aqueous solution. Its physical properties are influenced by various factors, such as its composition and processing methods. Measurement of physicochemical properties to determine the concentration of its components and evaluate the quality of milk products, according to Huppertz et al. (2020).

Raw milk quality is a multifaceted concept encompassing a wide range of characteristics. These include its chemical composition, physical properties,

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microbiological, sensory attributes, suitability for processing, and nutritional value (Czerniewicz et al., 2006). Physicochemical analysis is an essential method for evaluating the quality of dairy products. The quality of milk is intrinsically linked to its composition. Current practices for milk quality assessment rely heavily on laboratory analysis, which can be time-consuming and costly. To enhance efficiency in milk processing and facilitate timely interventions in animal health issues and dietary adjustments, to optimize milk production (Shkirin et al., 2021). Aernouts et al. (2015) and Ragni et al. (2016) indicated that fat and protein are the most important criteria for milk quality in dairy manufacturers. This contributes to determining the product's price and the health of the animals.

The continuous improvement of industrial activities is horizontal motivation that affects the most traditional and most recent processes. Enhancements in production lines can typically be achieved by replacing outdated equipment and technologies, and by modifying equipment materials. Additionally, adapting and refining analysis and control techniques during processes can result in significant short-term improvements without substantial economic and time costs (Verdú et al., 2018). Currently, the accurate measurements of the concentration of milk components are performed, for example magnetic resonance; conventional digital imaging; ultraviolet illumination, visible light effects, and infrared spectroscopy; electrical conductivity; fiber-optic sensors; among others (Gastélum-Barrios et al., 2020).

Slavica et al. (2012) investigated the α -tocopherol content in raw cow milk, and goat milk commercial using reversed-phase high-performance liquid chromatography with fluorescence detection (ex 295 nm, em 330 nm) and ultraviolet detection at 286 and 292 nm. Their findings revealed that goat milk had significantly higher α -tocopherol levels compared to cow milk. Specifically, raw goat milk with an average fat content of 4.4% contained $1.25 \mu\text{g mL}^{-1}$ of α -tocopherol, whereas raw cow milk with an average fat

content of 3.8% contained $0.66 \mu\text{g mL}^{-1}$. This demonstrates that goat milk has approximately twice the α -tocopherol content of cow milk. Spectroscopy using an insertion-type fiber optic probe and a sensor with wavelengths from 400 to 1100 nm was applied to measure milk fat content in a study by Ohtani et al. (2005) in dairy farms. The internal reflection ratios of 183 milk samples were determined using fiber optic spectroscopy at different temperatures. The best accuracy of determination was found for an equation obtained using smoothed internal reflection data and three-factor partial least squares at 20°C. The correlation coefficients between the predicted and reference milk fat were $r = 0.753$, $r = 0.796$, and $r = 0.783$ at 5°C, 20°C, and 40°C, respectively. By evaluating the protein and fat content of 50 milk samples using laser light scattering method compared to the conventional methods Rose-Gottlieb for fat and Kjeldahl for nitrogen determination, Xin et al. (2006) found that the laser light scattering theory, the ratio of the scattered light (at $90 \pm 0.05^\circ$ scattering angles) intensity to the transmitted light intensity. Also, laser light scattering provides a simple and direct method for rapid determination of fat and protein in milk compared to conventional methods.

Spectral analysis techniques have been used in the field of food safety. Fu et al. (2014) demonstrated that the combination of near-infrared spectroscopy and spectral similarity analysis (spectral angle measure, spectral correlation measure, and Euclidian distance measure) was effective in distinguishing melamine adulteration in milk powders. These spectral methods can detect adulteration with any type of multiple chemicals in milk powders.

The present study was conducted to measure milk physiochemical properties of sheep, goat and camel and analyze and measure optical properties by laser technique to predict milk quality.

2 Material and methods

2.1 Sample of animals

Sheep: Variety of Abo Delik in age of ranged between 4 – 5 years.

Goat: Variety of Baladi (hillysiret) in age of ranged between 3 – 4 years.

The feeding is component feed (55% corn, 10% seed cotton, 10% seed soya, 1% salt, 2% sodium carbonate, 1% metal salt, 0.5% yeast, 0.3% antibiotic mixture, 1% bicarbonates, and 20% straw bran) and berseem hay.

Camel: Variety of white (Shalateen original) in age of ranged between 4 – 5 years and it was fed grazed plus add feed (berseem hay + separated flours).

All breeding place is Halaib area, which has long daylight of in South of Egypt. Temperature ranged between 40°C -45°C in June month, humidity less than 60%.

2.2 Samples of milk

Milk samples from 30 female camels at Halaib and Shalateen areas of lactation were collected at random from camel-rearing areas around Halaib and Shalateen Districts. Milk samples (1000 mL) each of sheep, goat, and camel were collected once a week from Halaib and Shalateen area, Halaib Research Station, Desert Research Center (located in Southeastern Egypt between latitudes 23-22 South in the zone of Elba Natural Reserve. They is following The Red Sea Governorate) during the period from June to August 2024. The composite samples of milk were proposed withdrawn from the morning and evening milking of the individuals.

Milk samples after collected in clean and sterilized sample bottles and transported to the Laboratories of Desert Research Center and Agriculture Faculty at University, Egypt for analysis. These samples were labeled, ice packed and transported to the laboratory. All milk samples were then placed in the refrigerator at 4°C for further analysis. Total samples of sheep, goat, and camel milk were analyzed.

2.3 Methods

2.3.1 Physico-chemical characteristics

The physical characteristics of various milk samples were determined according to AOAC (2023). The total solids, total nitrogen (using micro-Kjeldahl method) and ash (using Thermolyne, type 1500

Muffle Furnace) contents, acidity, as well as pH values determined by using digital pH meter (Inolad model 720, Germany) in fresh milk treatments according to the method of AOAC (2023). Determination of the total fat content of sample was done by modified Gerber Method (Singh, 2014). Total carbohydrates were calculated by the difference for all samples analyzed.

2.3.2 Optical properties

The laser power was monitored before and after each exposure using a laser power meter (Gentec, Canada) to ensure proper energy delivery to the target site, a laser spot size of diameter 15 mm using a focusing lens. Before each experiment, it was confirmed that the laser beam was spread out uniformly over the entire target area (Figure 1).

He-Ne laser: a helium-neon (He-Ne) laser with a wavelength of 632.8 nm, and power of 4 mW, and an intensity of 4200 lux was used as the light source. The laser was supported by a stand. Laser source specifications are shown in Table 1.

Lens: A 75 mm-diameter convex silica glass lens with a 100 mm focal length was utilized. The lens was put between the milk samples and the luxmeter with an angle of 45 degree to focus the reflected light and collect it on the luxmeter detector.

HOLDERS: Holders fabricated from copper were used to hold the lens, sample, luxmeter detector.

Digital luxmeter: A digital luxmeter with high accuracy and sensitivity was used to measure the intensity of light reflection from milk surface and collected by a concave lens to luxmeter detector. Digital luxmeter with ranges of 0-50,000 lux.

The absorption of milk was calculated from the following equation according to the energy conservation law:

$$I = R + A \quad (1)$$

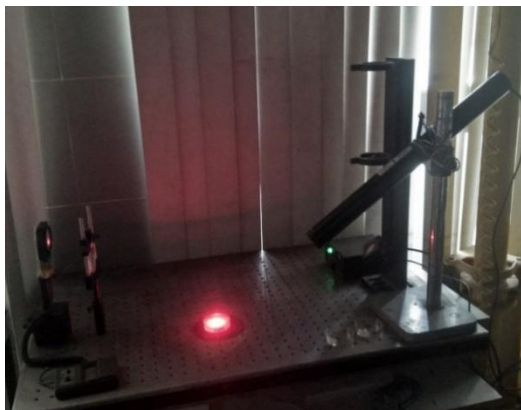
where, I is the incident beam (lux), R is the reflective beam (lux), and A is the absorptive beam (lux).

2.3.3 Statistical analysis

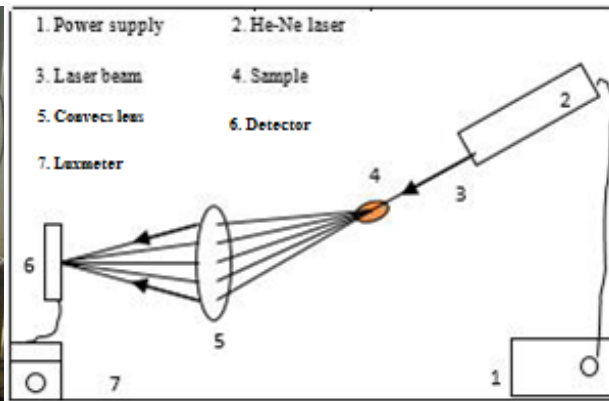
The results obtained were subjected to analysis of variance (ANOVA). Mean comparisons were carried

out among yogurt products. Statistical analysis was carried out by Statistical Analysis System (SAS, 2012), utilizing the General Linear Model (GLM)

with treatments as the main effect. Duncan's multiple ranges were employed at $p \leq 0.05$ to differentiate the means of three replicates.



(a) Photo of helium-neon laser



(b) Designed apparatus

Figure 1 Laser optical apparatus for optical properties of different milk types of samples

Table 1 Laser source and digital luxmeter specification to measure light reflection density of milk

No.	Specifications of helium-neon (He-Ne) laser		Specifications of digital luxmeter	
	Item	Details	Items	Details
1	Source of manufacture	USA	Source of manufacture	Japan
2	Model	05-LGR-173	Model	Lx-101
3	Type	Gas laser	Display	13 mm LCD (Liquid Crystal Display)
4	Wavelengths, nm	543.5	Ranges	0-50,000 lux 3 ranges
5	Mode	Continuous wave	Over-input	Indication of "1"
6	Out put power, mW	4	Sampling time	0.4 second
7	Beam diameter, mm	0.75	Operating temperature	0°C to 50°C. (32°F – 122°F)
8	Beam divergence, mrad	0.92	Operating humidity	Less than 80% R.H.
9	Polarization ratio	Random	Dimension	108 x 73 x 23 mm (4.3 x 2.9 x 0.9 inch)
10	Weight, kg	0.61	Weight	160 g (0.36 lb) including battery
11	In put current, Ac, Amp.	220, 3	Power supply	006P DC 9 V, 2 mA battery

3 Results and discussion

The overall average physicochemical composition of goat, sheep and camel milk is presented in Table 2. It shows that except for pH, fat and ash, other milk compositions, i.e., protein, total carbohydrates and total solids had wide change ranges. pH value of goat, sheep and camel milk were not significantly ($p > 0.05$) different from each other. These results are agreement with those values reported by Sabahelkhier et al. (2012). The pH values of goat and camel milk were similar with findings of Al-Juboori et al. (2013) and Legesse et al. (2017). The higher protein content, ash and total solids are observed in sheep milk followed by goat and camel milk. The amount of protein content and total carbohydrates in sheep milk were higher than that in the milk of other species at highly significant ($p \leq 0.05$). These results were in accordance with the findings of Mahmood and Usman (2010) and

Legesse et al. (2017).

The total solid content of milk sample collected from camel was slightly less than that of milk of goat and sheep. Statistical analysis showed significant ($p \leq 0.05$) difference between the concentration of total solids in goat, sheep and camel milk. The total solid amount in goat, ewe and camel milk were like that reported by Legesse et al. (2017). The lowest fat content is observed in camel milk compare the other species. The milk composition differs considerably as reported by Kalyankar et al. (2016) due to genetic factors, physiological factors, nutritional factors, frequency of milking, and environmental conditions.

Figure 2 shows the relationship between Laser reflection percentage and both pH value and total solids percentage at different milk types. It was noticed that the Laser reflection percentage increased by increasing pH value, which Laser reflection percentage were 3.11%, 3.33%, and 3.78% for the pH

of 6.65, 6.54, and 6.67 values, at sheep, goat, and camel milk types, respectively. On the contrary, it was noticed that the Laser reflection percentage increased by decreasing total solids percentages,

which Laser reflection percentage were 3.11%, 3.33%, and 3.78% for the total solids percentage of 14.40%, 13.30%, and 11.58%, at sheep, goat, and camel milk types, respectively.

Table 2 Physico-chemical of milk sample

Group	pH	Fat (%)	Protein (%)	Ash (%)	Total carbohydrates (%)	Total solids (%)
Goat milk	6.64	3.45 ^a	3.60 ^b	0.84	5.45 ^b	13.30 ^{ba}
Sheep milk	6.65	4.45 ^a	4.05 ^a	0.90	5.00 ^a	14.40 ^a
Camel milk	6.67	2.63 ^b	3.27 ^c	0.81	4.87 ^c	11.58 ^c
±SE	0.14	0.37	0.09	0.03	0.14	0.62

^{a-c} Superscript lowercase letters in each column indicate statistically significant difference ($p < 0.05$)

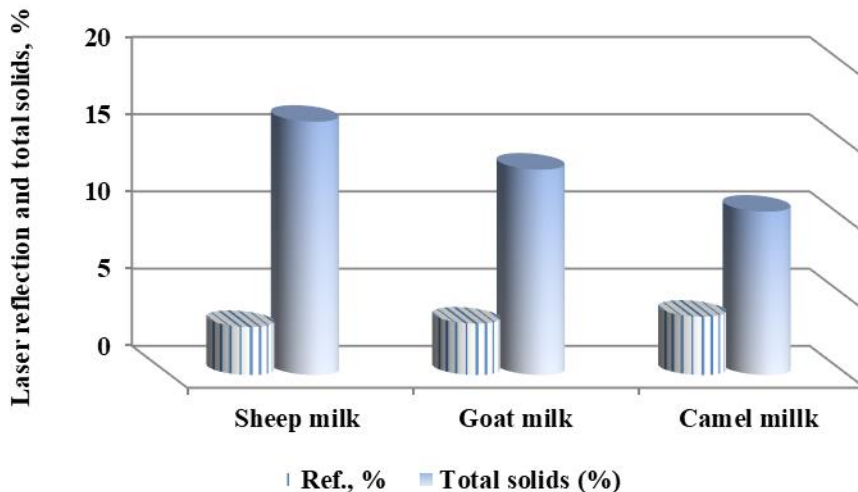


Figure 2 Relationship between Laser reflection, pH and total solids at different milk types

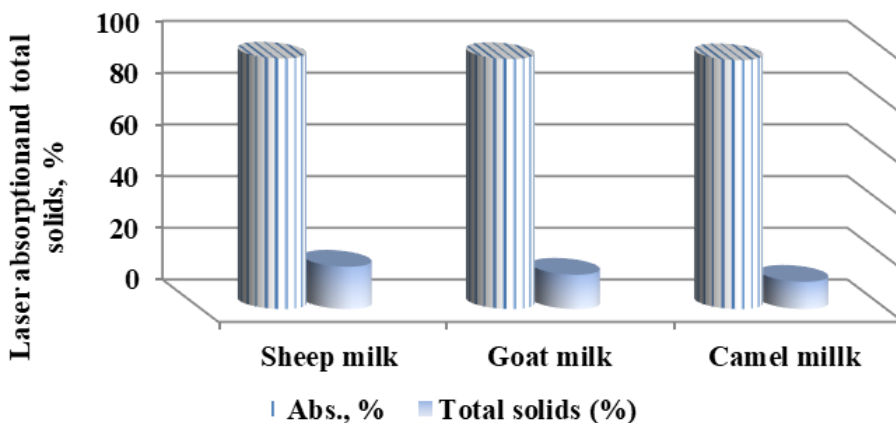
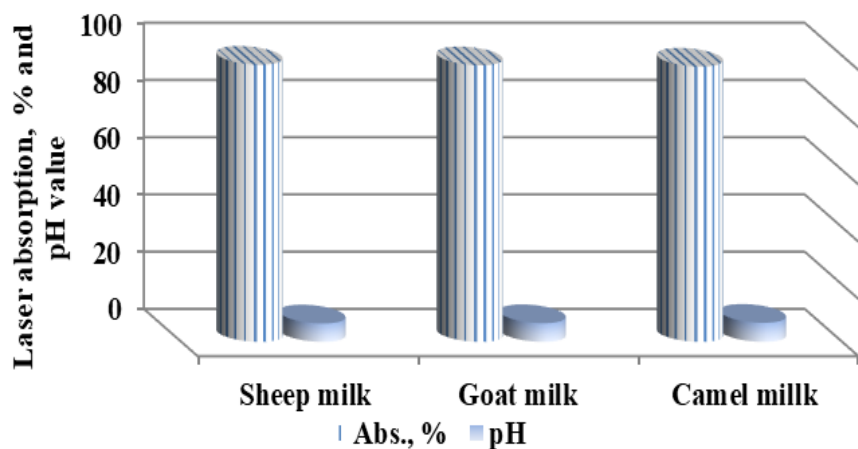


Figure 3 Relationship between Laser absorption, pH and total solids at different milk types

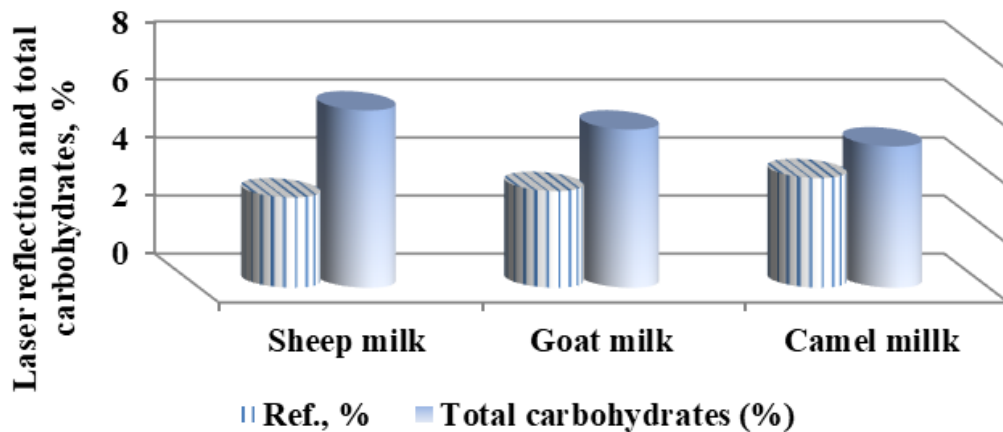
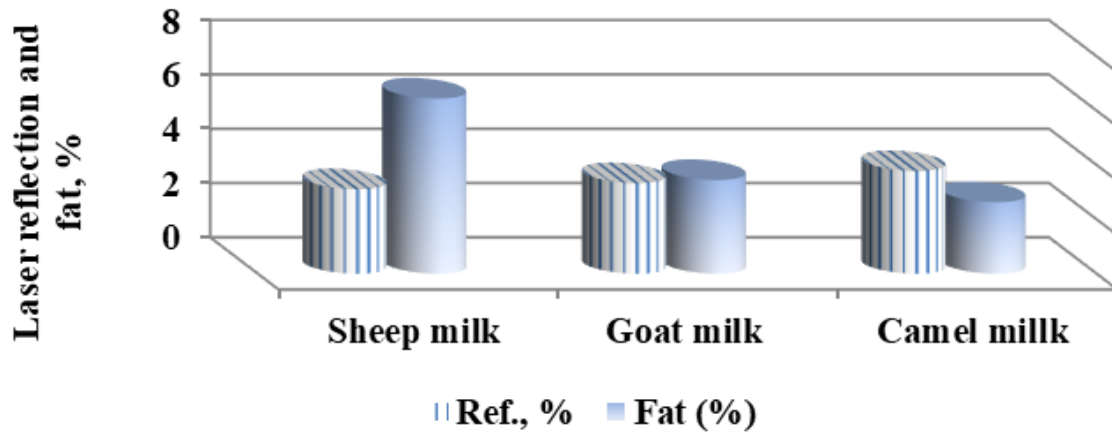
From the previous results, it was clear there is a direct relationship between Laser reflection percentage and pH value. While there is an inverse relationship between the Laser reflection percentage and the total solids percentages. This result is similar to Junior et al. (2022), where pH value decreases with increasing concentration of total solids of milk powder infantile formula.

Figure 3 shows the relationship between Laser absorption percentage and both of pH value and total solids percentage at different milk types. It was noticed that Laser absorption percentage decreased by increasing pH value, which Laser absorption percentage were 96.89%, 96.67%, and 96.22% for the pH of 6.65, 6.54, and 6.67 values, at sheep, goat, and camel milk types, respectively.

On the same Figure 3 shows the relationship between Laser absorption percentage and total solids percentage at different milk types. It was noticed that the Laser absorption percentage decreased by decreasing total solids percentages, which Laser absorption percentage were 96.89%, 96.67%, and

96.22% for the total solids percentage of 14.40%, 13.30%, and 11.58%, at sheep, goat, and camel milk types, respectively. From the previous results, it was clear there is an inverse proportion between Laser absorption percentage and pH value. While there is a direct proportion between the Laser absorption percentage and the total solids percentages

Figure 4 shows the relationship between Laser reflection percentage, fat, protein, ash and carbohydrate percentage at different milk types. It was noticed that the Laser reflection percentage were increased by decreasing fat, protein, ash and carbohydrate percentage, which Laser reflection percentage were 3.11%, 3.33%, and 3.78% for the (fat of 6.45%, 3.45%, and 2.63%), (protein of 5.05%, 3.61%, and 3.27%), (ash of 0.91%, 0.84%, and 0.81%), and (total carbohydrates of 6.11%, 5.45%, and 4.87%), at sheep, goat, and camel milk types, respectively. From the previous results, it was clear there is an inverse proportion between Laser reflection percentage and fat, protein, ash and carbohydrate percentage.



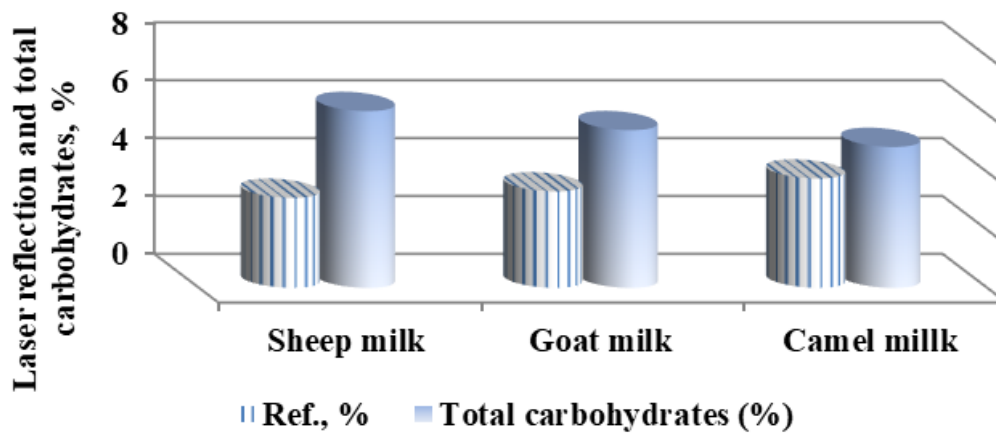
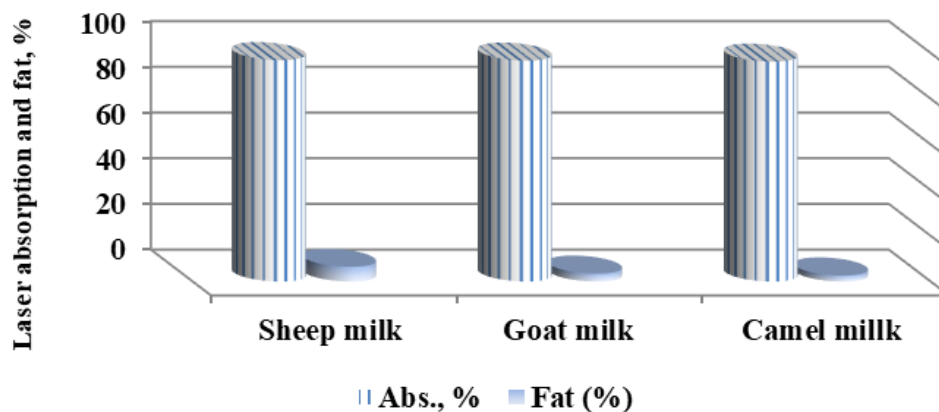


Figure 4 Relationship between Laser reflection, fat, protein, ash and carbohydrates at different milk types

Figure 5 shows the relationship between Laser absorption percentage, fat, protein, ash and carbohydrate percentage at different milk types. It was noticed that the Laser absorption percentage were decreased by decreasing fat, protein, ash and carbohydrate percentage, which Laser absorption percentage were 96.89%, 96.67%, and 96.22% for the (fat of 4.45%, 3.45%, and 2.63%), (protein of 4.05%, 3.60%, and 3.27%), (ash of 0.91%, 0.84%, and 0.81%), and (total carbohydrates of 5.00%, 5.45%, and 4.87%), at sheep, goat, and camel milk types, respectively. From the previous results, it was clear there is a direct proportion between Laser absorption percentage and fat, protein, ash and carbohydrate percentage.

The result of the research has proven the feasibility of using laser for milk analysis. Moreover, the results showed that using lasers contributed to the assessment of the fat content of different milk types, with the highest fat content in sheep and goat milk compared to camels. Consequentially, the remaining

milk components, including protein, carbohydrates, and ash, were also consistent with traditional experimental results for the chemical analysis of different milk components. These results are similar to those reported by Muhamad Kamil et al. (2021) when comparing the properties of oat, soy, almond, and natural milk using random laser and light propagation techniques. Also, these results were similar to those reported by Shkirin et al. (2021) when analyzing protein content using laser polarimetry. And Shkirin et al. (2022) when estimating the percentage of fat and somatic cells in milk using lasers. They were also similar to those reported by Abegão et al. (2016) when measuring fat in ultra-high temperature milk using random laser emission. Also, Wang et al. (2023) demonstrated that lasers can be used in milk analysis by the reflectance to characterize the particle size distribution of hyper dispersed suspensions and measure the light scattering using some functions.



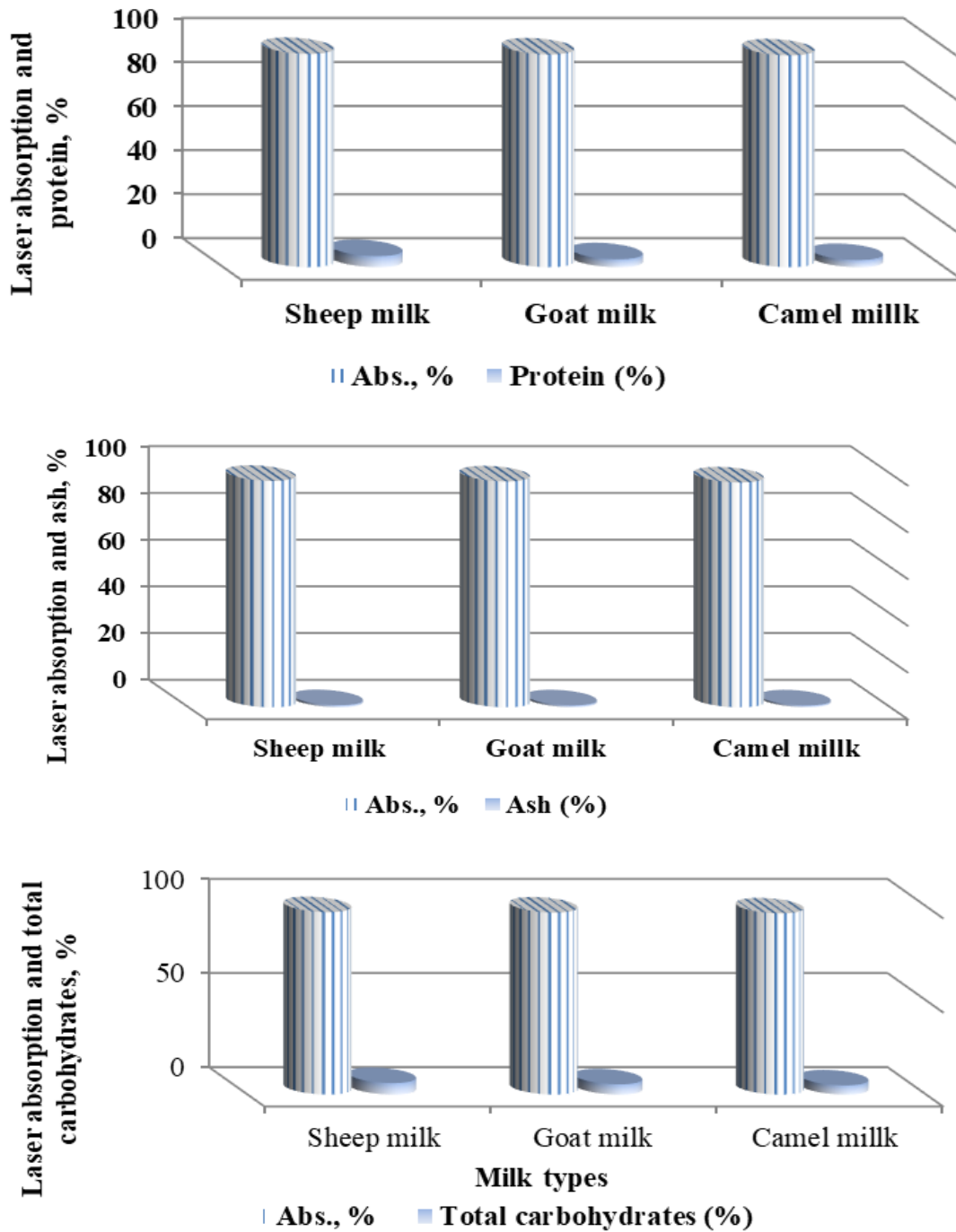


Figure 5 Relationship between Laser absorption, fat, protein, ash and total carbohydrate at different milk types

4 Conclusion

Physiochemical properties such as acidity, fat, protein, ash, total solid and total carbohydrate have been observed and determined for various samples of milk i.e. sheep milk, goat milk, and camel milk, The conclusive can be summarized in the following points;

1. Total solids and pH in milk have been measured in terms of % of lactic acid, and order in different samples of milk is obtained as: sheep milk < goat milk < camel milk.

2. Fat, protein, ash, and total carbohydrate content determined in various samples of milk have been reported, and order in different samples of milk is obtained as: sheep milk > goat milk > camel milk.

3. There is direct proportion between Laser reflection percentage and pH value. While, there is inverse proportion between the Laser reflection percentage and the total solids percentage.

4. There is inverse proportion between Laser absorption percentage and pH value. While, there is

direct proportion between the Laser absorption percentage and the total solids percentage.

5. There is inverse proportion between Laser reflection percentage and fat, protein, ash and carbohydrate percentage. While there is direct proportion between Laser absorption percentage and fat, protein, ash and carbohydrate percentages.

6. Laser techniques applied are available, fast, and easy used.

Therefore, Laser technology is a less expensive system for measuring milk composition and distinguishes between the properties of milk from different types compact. Also, it is easy to calibrate, combined with an increased level of accuracy, would have advantages in terms of reducing milk processing costs and improving quality control.

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References

- Abegão, L. M. G., A. A. C. Pagani, S. C. Zílio, M. A. R. C. Alencar, and J. J. Rodrigues Jr. 2016. Measuring milk fat content by random laser emission. *Scientific Reports*, 6(1): 35119.
- Aernouts, B., R. Van Beers, R. Watté, T. Huybrechts, J. Lammertyn, and W. Saey. 2015. Visible and near-infrared bulk optical properties of raw milk. *Journal of Dairy Science*, 98(10): 6727–6738.
- Al-Juboori, A. T., M. Mohammed, J. Rashid, J. Kurian, and S. El Refaey. 2013. Nutritional and medicinal value of camel (*Camelus dromedarius*) milk. *WIT Transactions on Ecology and the Environment*, 170: 221-232.
- AOAC. 2023. *Official Methods of Analysis*. 22nd ed. Arlington, Virginia, USA: Association of Official Analytical Chemistry.
- Czemiewicz, M., K. Kielczewska, and A. Kruk. 2006. Comparison of some physicochemical properties of milk from Holstein-Friesian and Jersey cows. *Polish Journal of Food and Nutrition Sciences*, 15(1): 61–64.
- Fu, X., M. S. Kim, K. Chao, J. Qin, J. Lim, H. Lee, A. Garrido-Varo, D. Pérez-Marín, and Y. Ying. 2014. Detection of melamine in milk powders based on NIR hyperspectral imaging and spectral similarity analyses. *Journal of Food Engineering*, 124(3): 97–104.
- Gastélum-Barrios, A., G. M. Soto-Zarazúa, A. Escamilla-García, M. Toledano-Ayala, G. Macías-Bobadilla, and D. Jauregui-Vazquez. 2020. Optical methods based on ultraviolet, visible, and near-infrared spectra to estimate fat and protein in raw milk: A review. *Sensors*, 20(12): 3356.
- Huppertz, T., T. Uniacke-Lowe, and A. Kelly. 2020. Physical chemistry of milk fat globules. In *Advanced Dairy Chemistry, Volume 2 Lipids*, eds. P. L. H. McSweeney, P. F. Fox, and J. A. O'Mahony, ch. 5, 133-167. Switzerland: Springer Nature.
- Junior, R. O. S., J. E. Gomes-Filho, W. C. Almeida, M. D. M. Bezerra, C. A. M. Falcão, and M. Â. A. L. Ferraz. 2022. Evaluation of pH and total soluble solid (°brix) on the cariogenic and erosive potential of milk powder infantile formula. *Research Society and Development*, 11 (15): e588111537063.
- Kalyankar, S. D., C. D. Khedkar, A. M. Patil, and S. S. Deosarkar. 2016. Milk: Sources and composition. In *The Encyclopedia of Food and Health*, eds. B. Caballero, P. M. Finglas, and F. Toldrá, 724 - 728. Amsterdam, Netherlands: Elsevier, 724-728.
- Legesse, A., F. Adamu, K. Alamirew, and T. Feyera. 2017. A comparative study on the physicochemical parameters of milk of camel, cow and goat in Somali Regional State, Ethiopia. *Chemical Sciences Journal*, 8(4): 1000171.
- Mahmood, A., and S. Usman. 2010. A comparative study on the physicochemical parameters of milk sample collected from buffalo, cow, goat and sheep of Gujrat, Pakistan. *Pakistan Journal of Nutrition*, 9(12): 1192-1197.
- Muhamad Kamil, N. A. I., W. Z. Wan Ismail, I. Ismail, J. Jamaludin, N. S. Hanasil, and R. K. R. Ibrahim. 2021. Analysis of milk from different sources pased on light propagation and random laser properties. *Photonics*, 8(11): 486.
- Ohtani, S., T. Wang, K. Nishimura, and M. Irie. 2005. Milk fat

- analysis by fiber-optic spectroscopy. *Asian-Australasian Journal of Animal Sciences*, 18(4): 580-583.
- Ragni, L., E. Iaccheri, C. Cevoli, and A. Berardinelli. 2016. Spectral-sensitive pulsed photometry to predict the fat content of commercialized milk. *Journal of Food Engineering*, 171: 95–101.
- Sabahelkhier, M. K., M. M. Faten, and F. I. Omer. 2012. Comparative determination of biochemical constituents between animals (goat, sheep, cow and camel) milk with human milk. *Research Journal of Recent Sciences*, 1(5): 69-71.
- SAS 2012. SAS/Stat. user's guide: Statistics, system for windows, version 12.1. Cary, North Carolina, USA: SAS Inst., Inc.
- Shkirin, A. V., D. N. Ignatenko, S. N. Chirikov, N. F. Bunkin, M. E. Astashev, and S. V. Gudkov. 2021. Analysis of fat and protein content in milk using laser polarimetric scatterometry. *Agriculture*, 11(11): 1028.
- Shkirin, A. V., M. E. Astashev, D. N. Ignatenko, N. V. Suyazov, M. V. Vedunova, and S. V. Gudkov. 2022. Laser scatterometric device for inline measurement of fat percentage and the concentration level of large-scale impurities in milk. *Applied Sciences*, 12(24): 12517.
- Singh, A. P. 2014. Comparison of physicochemical properties of raw milk from Indigenous and Exotic Cows at Allahabad. *International Journal of Science and Research (IJSR)*, 3(8): 1566-1568.
- Slavica, S., J. Živković, R. Pavlović, G. Kocić, N. Trutić, and S. Živanović. 2012. Assessment of α -tocopherol content in cow and goat milk from the Serbian market. *Hemijaska Industrija*, 66(4): 559–566
- Verdú, S., J. M. Barat, and R. Grau. 2018. Non destructive monitoring of the yoghurt fermentation phase by an image analysis of laser-diffraction patterns: characterization of cow's, goat's and sheep's milk. *Food Chemistry*, 247: 46-54.
- Wang, X., L. Ke, S. C. Lai, Q. Zhu, X. Sun, and S. J. Chua. 2023. Determination of milk content by a laser light scattering technique. *Journal of Materials Science: Materials in Electronics*, 34: 146.
- Xin, Q., H. Ling, T. Long, and Y. Zhu. 2006. The rapid determination of fat and protein content in fresh raw milk using the laser light scattering technology. *Optics and Lasers in Engineering*, 44(8): 858–869.