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RESEARCH ARTICLE

Reduced Carbon Monoxide Emission in Ghee Lamp than Peanut Oil Lamp

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Abstract. Lighting the lamp is an ancient tradition of Indian culture. Various cultures such as Indian, Chinese, Tibetan, Japanese, etc. widely use ghee for religious purposes. In India, Ghee is an essential component of most of the rituals. Ayurveda suggests different types of vegetative oils and ghee (clarified butter) for Ayurvedic preparations. Both ghee and peanut oil are commonly used in food preparations. Besides for eating, both ghee and peanut oil lamps are also commonly used for lighting lamps in India. Hence, evaluating the emissions from these lamps is of interest. In the present comparative study we have evaluated the emission of air pollutants: Particular Matter (PM1, PM2.5, PM10), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Ozone, Carbon Monoxide (CO), and Carbon Dioxide (CO_2) from peanut oil and ghee lamps. We found that there was no significant difference between oil and ghee lamps for all emissions except for CO, where there was a significant reduction (15.93%, p= 0.0183) in ghee lamps compared to peanut oil lamps. Lower CO from ghee lamps than that from peanut oil lamps might be due to differences in the combustion efficiency resulting from chemical structure differences. Thus, the present finding of reduced CO emission from ghee lamps supports its wide use as a component in Indian religious purposes, Vedic-rituals of Yagya or Havan and meals.

Keywords. Ghee, Peanut oil, Lamp, Carbon monoxide, Air pollutants.

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Introduction

Ayurveda suggests different types of vegetable oils and ghee (clarified butter) for different Ayurvedic preparations for prevention and treatment of diseases, strengthening the digestive system by absorption and assimilation of nutrients in the body, strengthening the nervous system and memory enhancement and also to balance Vata, Pitta and Kapha Prakriti [1]. In addition to that, it is also used for cosmetics. Indian religious texts describe the use of different types of vegetable oils and ghee for different kinds of worship, such as the use of mustard oil for worship of Saturn [2]. Ghee and oils are also used for lamps in various rituals. Lighting the lamp is an ancient tradition of Indian culture.

In Indian temples, the cow ghee is given more importance for lighting the lamp. The use of ghee for lighting the lamp is practised not only in Indian temples, rituals and worship but also in Buddhism, Chinese, Tibetan and other cultures [3–5]. The ghee lamp is used for maintaining purity while cooking priest food in the shrine of Buddha and the ghee lamp is also used for light at the Buddha temples at the time of mantra recitation [3]. Also in China, ghee lamps are kept in temples [5]. In Tibetan culture ghee is made into cylindrical oil lamps and used for religious practices [6].

Besides eating, both the ghee and peanut oil are used for lamps by common people in India. Hence, the emissions of these lamps are of scientific interest. A study by Zhang et al. (2022) on the combustion of the yak ghee lamp, yak dung, medicinal wood, Tibetan incense, diesel, coal, wood etc. showed that yak ghee had significantly lower (7.5%) brown carbon emission (contributor to global warming) compared to all the other burning material (44.6% to 89.2%), signifying its importance as a burning material [6]. To the best of our knowledge, there is no comparative study available on the emission of air pollutants from combustion of ghee and oil. In the present study, we have compared the emission of air pollutants from burning of peanut oil and ghee in a lamp.

Materials and Methods

Material and Instruments

Refined peanut oil was brought from the local market, ghee (clarified butter) was obtained from Shantikunj-Haridwar Gaushala. The cow breed was Sahiwal (*Bos taurus indicus*). The lamp was made up of metal and was purchased from the local market (Figure 1, top panel left).

Peanut oil and ghee were poured into lamps and muslin cloth was used as the lamp wick. A 2.5 X 5 cm muslin cloth was rolled and passed through the holder of a metal lamp. The top portion of the wick was cut and adjusted to 1 cm (Figure 1, top panel middle). The experiment was carried out in a 3x2x2 feet biosafety cabinet (SSI-127, RA Scientific Instruments, Pitampura, Delhi, India) in which a gas analyzer (indoor air quality monitor from Prana Air, Rohini, Delhi) was placed for measuring air pollutants [Particular Matter, Carbon Monoxide, Carbon Dioxide, Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Ozone (O_3)] (Figure 1, bottom panel).

Experimental procedure and Analysis

The lamp was lit and kept for three minutes in room-1 before placing it in the biosafety cabinet (room-2). The gas analyzer was already kept switched on inside the cabinet for the base reading (pre-reading, 5 minutes). The lamp was kept inside the cabinet (for exactly ten minutes) and it was closed. After that the lamp was taken to room-1. The cabinet was kept open and post-reading (5 minutes) was taken. The experiment was done in pairs i. e., ghee lamp followed by oil lamp or contrariwise. Before starting the other experiment with either ghee or peanut oil lamp, a 1-hour break was maintained. However, each day's base-line varied for many of the pollutants hence, paired data was considered for ghee and oil lamp i.e., ghee lamp and oil lamp lit on the same day were paired. The experiment was repeated several times. The readings obtained from the gas analyzer were collected-plotted and analysed using the two tailed paired student's t test.

Figure 1: Experimental Setup. Top panel of the image shows the metal lamp (left), metal lamp containing muslin cloth wick (middle), and bottom image shows bio-safety cabinet containing oil lamp and gas analyzer.

Pollutant	Geometric Mean+SD		P value	Significance
	Oil Lamp	Ghee Lamp		
PM1	2581+1.29	2576+1.27	0.8219	Ns
PM2.5	3227+1.29	3235+1.27	0.9441	Ns
PM10	3611+1.3	3627+1.28	0.9815	Ns
NO_2	4.524+1.2	4.544+1.32	0.7074	Ns
SO_2	10.84+3.28	12.62+2.76	0.9278	Ns
O_3	5.183+1.17	5.095+1.19	0.6725	Ns
CO	72.25+1.38	60.74+1.58	0.0183	<0.05
CO_2	132841+1.11	127524+1.15	0.2485	Ns

Table 1: Geometric mean and standard deviation of the area under the curve of oil and ghee lamps' 10 minutes emission. ns = not significant. *Significant, p-value <0.05.

Results

The present study evaluated emission of Particulate Matter (Figure 1), NO_2, SO_2, O_3 (Figure 2), CO, and CO_2 (Figure 3) when peanut oil and ghee lamps lit for 10 minutes. Pre-reading (5 minutes), post-reading (5 minutes) were taken (Table 1). The difference between oil (blue colour) and ghee lamp (red colour) was evaluated (Figure 1-3). Area Under curve of emission was measured for each emission. It was found that there was no significant difference between oil

and ghee lamp for all emissions [Particulate Matter (Figure 1B,1D,1F), NO_2 (Figure 2B), SO_2 (Figure 2D), O_3 (Figure 2F), and CO_2 (Figure 3D)] except for CO (Figure 3A, 3B) where there was a significant reduction (15.93%; Geometric Mean difference – 11.51; p value 0.0183) in ghee lamp compared to peanut oil lamp (Table 1).

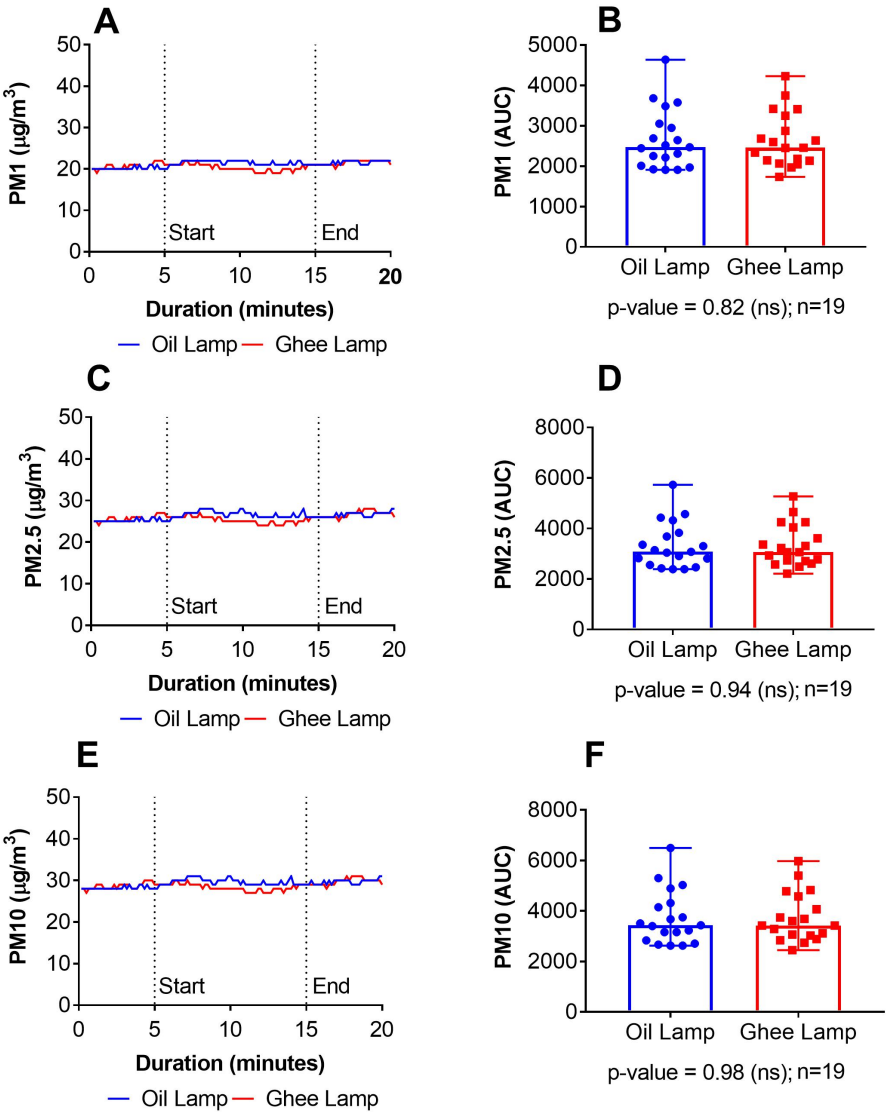

Figure 2: Measurement of particulate matter (PM) emission from peanut oil and ghee lamps lighted for 10 minutes. 0 to 5 minutes, pre-reading; 5 to 15 minutes, lamp was lit; 15 to 20 minutes, post-reading. Each minute contained 6 readings, the x-axis contained 120 readings. Average of 19 experiments for particulate matter 1 (PM1) (A), particulate matter 2.5 (PM2.5) (C), and particulate matter 10 (PM10) (E) of oil (blue) and ghee (red). Area under curve (AUC) of each 20 minutes experiment (n=19) for particulate matter 1 (PM1) (B), particulate matter 2.5 (PM2.5) (D), and particulate matter 10 (PM10) (F). ns = not significant.

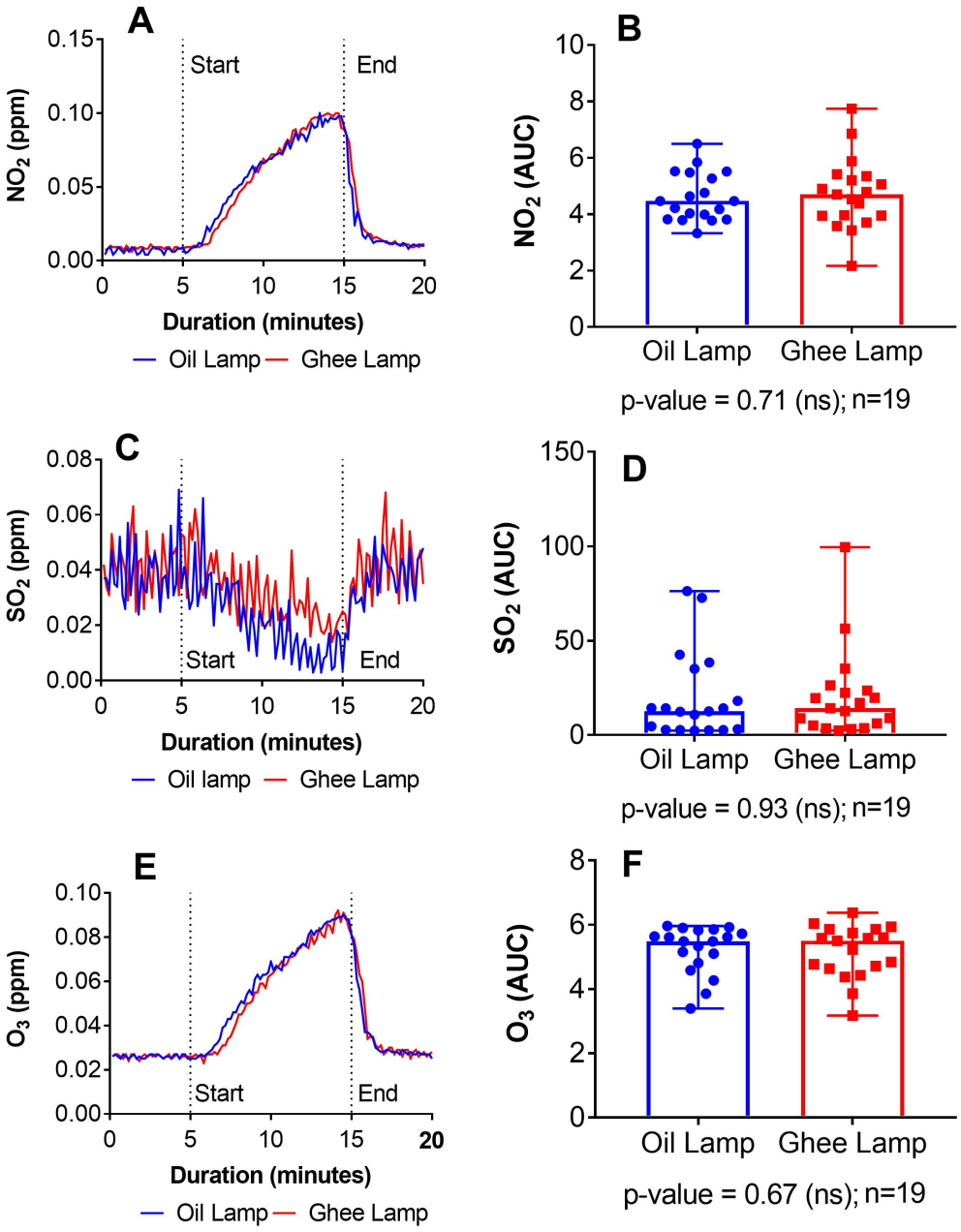

Figure 3: Measurement of Nitrogen Dioxide (NO_2), Sulphur dioxide (SO_2), and Ozone (O_3) emission from peanut oil and ghee lamps lighted for 10 minutes. 0 to 5 minutes, pre-reading; 5 to 15 minutes, lamp was lit; 15 to 20 minutes, post-reading. Each minute contained 6 readings, the x-axis contained 120 readings. Average of 19 experiments for Nitrogen Dioxide (NO_2) emission (A), Sulphur dioxide (SO_2) emission (C) and Ozone (O_3) emission (D) of oil (blue) and ghee (red). Area under curve (AUC) of each 20 minutes experiment (n=19) for NO_2 (B), SO_2 (D), and O_3(F). ns = not significant.

Discussion

Lighting the lamp at the time of rituals and worship is being practised in India and many other countries like China, Tibet, Japan. Some use candles while others prefer the traditional lamp. In India ghee lamps are given more im-

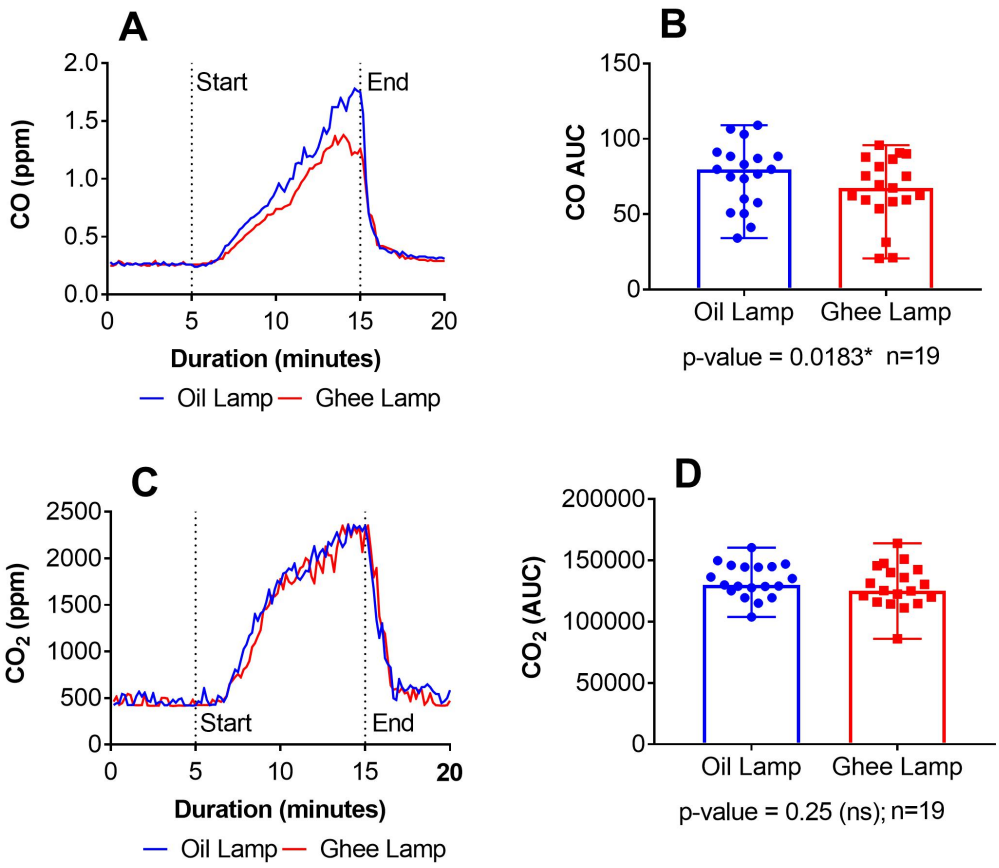

Figure 4: Measurement of carbon monoxide (CO) and carbon dioxide (CO_2) emission from peanut oil and ghee lamps lighted for 10 minutes. 0 to 5 minutes, pre-reading; 5 to 15 minutes, lamp was lit; 15 to 20 minutes, post-reading. Each minute contained 6 readings, the x-axis contained 120 readings. Average of 19 experiments for CO (A), and CO2 emission (C) of oil (blue) and ghee (red). Area under curve (AUC) of each 20 minutes experiment (n=19) for CO emission (B), and CO_2 emission (D). *Significant, p-value <0.05; ns = not significant.

portance than any other available oil for lamp and religious purposes.

In the present study, air pollutants i.e., PM, SO_2, NO_2, O_3, CO, and CO_2 were evaluated for peanut oil and ghee lamps. There were no changes in emission of air pollutants between oil and ghee lamps except there was a significant difference in CO emission (16%) between the peanut oil lamp and ghee lamp (Figure 1-3, Table 1) indicating the significance of use of the ghee lamp as compared to an oil lamp.

Carbon monoxide is a harmful gas and causes fatigue, headache, confusion, and dizziness due to inadequate oxygen delivery to the brain. CO is dangerous to health and can cause immediate death when CO is intoxicated; it bonds with haemoglobin (Hb), by displacing oxygen and forming carboxyhaemoglobin (COHb), resulting in a lack of oxygen in the blood which results in malfunctioning of the brain and heart. The attraction of CO and haemoglobin is approximately 250 times greater than that of oxygen and haemoglobin [11]. Combustion of ghee resulted in less CO concentration than burning of peanut oil and thus supporting the use of ghee in Havan rather than oils.

Previous study by Zang et al. showed that fuels with high combustion efficiency had low CO emission while fuels with low combustion efficiency had high CO level. They had shown that yak ghee had modified combustion efficiency of 1 largest among nine fuels tested (coal, wood, yak

dung, different wood mixtures of three types and diesel). They identified wood (0.92), coal (0.91) and diesel (0.97) had high modified combustion efficiency albeit lower than yak ghee (1.0). Yak dung (0.77) had the lowest modified combustion efficiency among tested fuels. Their results supported the present study data of lower CO emission of ghee to that of peanut oil (Figure 3; Table 1). Though modified combustion efficiency of peanut oil was not identified in the present paper, the lower CO in ghee lamp might also be resultant of more complete combustion than that of peanut oil, which might be due to their chemical structure which further needs to be studied. One of the obvious differences present in the peanut oil and ghee possibly contributing to the combustion process is their water content; ghee contains 0.3% moisture [12] while peanut oil contains 7% moisture [13]. However, there was no difference between the level of CO_2 in both the peanut oil lamp and ghee lamp (Figure 3, Table 1).

Indian scriptures also support the findings of the present study i.e., preference for ghee usage over oil. Peanut oil and ghee are majorly used in the diet because of their nutrient values and availability. Chemically ghee is a complex lipid of mixed glycerides together with a small amount of free fatty acids, phospholipids, sterols and their esters, fat-soluble vitamins (A, D, E and K), carotenoids, carbonyl compounds, hydrocarbons, charred casein, moisture and traces of elements like copper and iron. Ghee is the natural antioxidant [7–10, 14].

Indian scriptures like Veda, the Mahabharat also give importance to ghee over any edible oil or fat. According to Mahabharat cow milk is an elixir "Amritam Vai gvam khriramityah tridshadhip, tasmad dadatim yo dhenumamatrim sa Praychhti"; it implies that cow milk is an Elixir (amrita) therefore who donates the cow donates the Amrita [15]. Rigveda (1-71-9) also states that milk protects us from disease "Goshu Priyamamritam rakshmana" [16] and many Ayurvedic scriptures suggest the preparation of a number of medicines using ghee [15–17]. Rigveda says that milk given by cows has the curative and prophylactic effects of the medicinal herbs it eats. Ghee prepared by cow milk was thus used not only to cure but also as a preventive. There are, therefore, prayers in Rigveda and atharvaveda seeking that God may provide us with so much ghee that our houses are always full of this most nutritious food [16, 18]. According to Atharvaveda (3-12-8) ghee is Amrita "ghritasya dharamariten sambhritam" [17]. Similarly, at several other places in the Vedas (Rigveda (10-19-7) and Atharveda (2-13-1)), ghee has been described as a (flawless) Nirdosh food, which increases vigour and vitality [16], strengthens the body and helps enhance the life span [18].

In addition to the wide use of ghee as an important component of meal, Vedas describe ghee as the most essential ingredient for performing Yagya or Havan. In the present study, the concentration of CO was found to be reduced in a ghee lamp but not in a peanut oil lamp supporting its traditional use for health and rituals.

Compliance with ethical standards Not required.
Conflict of interest The authors declare that they have no conflict of interest.

References

[1] Charaka Samhita edited by Vaidya Jadavaji, Trikamji Acharya, Chaukhamba Surbharati Prakashan, Varanasi Reprint edition, Nidanasthana chapter 01 sloka, 1992; 37, 231-232.

[2] Larios B. From the Heavens to the Streets: Pune's Wayside Shrines. Samaj 2018. https://doi.org/10.4000/samaj.4549.

[3] Ray PR. Technological and Biochemical Aspects of Ghee (Butter Oil). Engineering Practices for Milk Products 2019:83–109. https://doi.org/10.1201/9780429264559-5.

[4] Gellner DN. A Newar Buddhist Liturgy: Śrāvakayānist Ritual in Kwā Bāhāḥ, Lalitpur, Nepal. Journal of the International Association of Buddhist Studies. 1991 Dec 31:236-52. Page no. 242, 244.

[5] Qin J, Weng WG. Preliminary study of water mist suppressing ghee flame in historical building in the northwest China. Journal of Cultural Heritage 2006;7:329–33. https://doi.org/10.1016/j.culher.2006.09.001.

[6] Zhang X, Xu J, Zhai L, Zhao W. Characterization of Aerosol Properties from the Burning Emissions of Typical Residential Fuels on the Tibetan Plateau. Environ Sci Technol 2022;56:14296–305. https://doi.org/10.1021/acs.est.2c04211.

[7] PENA-SERNA C, RESTREPO-BETANCUR LF. Chemical, physicochemical, microbiological and sensory characterization of cow and buffalo ghee. Food Sci Technol 2020;40:444–50. https://doi.org/10.1590/fst.32219.

[8] List GR. Processing and Food Uses of Peanut Oil and Protein. Peanuts 2016:405–28. https://doi.org/10.1016/b978-1-63067-038-2.00015-0.

[9] Akhtar S, Khalid N, Ahmed I, Shahzad A, Suleria HAR. Physicochemical Characteristics, Functional Properties, and Nutritional Benefits of Peanut Oil: A Review. Critical Reviews in Food Science and Nutrition 2014;54:1562–75. https://doi.org/10.1080/10408398.2011.644353.

[10] Santhosh Shivan, Ranjith , Shyam Prakash K, A. Gowrisankar. Biodiesel From Peanut Oil And Its Emission And Performance Charecteristics In Four Stroke Ic Engine. International Research Journal of Engineering and Technology. 2019. Volume: 06 Issue: 03 pages- 5089-5094.

[11] Rose JJ, Wang L, Xu Q, McTiernan CF, Shiva S, Tejero J, et al. Carbon Monoxide Poisoning: Pathogenesis, Management, and Future Directions of Therapy. Am J Respir Crit Care Med 2017;195:596–606. https://doi.org/10.1164/rccm.201606-1275ci.

[12] United States Department of Agriculture, USDA specifications for ghee. Effective October 19, 1993. Available from https://www.ams.usda.gov/sites/default/files/media/ghee.pdf

[13] Jie Chen, Lihua Zhang, Qing Zhang. Research on exacting oil technique of peanut with low temperature.Advances in Engineering Research. 2017;136:126-130. Available from https://www.atlantis-press.com/article/25878265.pdf

[14] Hazra, Tanmay Parmar, Pankaj. Natural Antioxidant Use in Ghee-A Mini Review. Journal of Food Research and Technology. 2014;2:101-105.

[15] N.V.R. Krishnamacharya. The Mahabharata. Tirupati :Tirumala Tirupati Devasthanams, 1983. Anu.65-46

[16] Sharma Pt.Shri Ram. Rigveda. Yug nirman yojna Mathura. 1965.

[17] Amr AS. Role of some aromatic herbs on extending the stability of sheep ghee during accelerated storage. Egyptian Journal of Dairy Science, 1990b: 18: 335.

[18] Sharma S, Sharma B. Atharvaved Sanhita, (3-12-1). 2014th ed. Yug nirman yojana vistar trust, Gayatri Tapobhumi, Mathura; 1961.