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Latest Methodology to Check the Adulteration of Vegetable Oils in Milk Fat: A Review

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ABSTRACT

Ghee is one of the premium fats under the edible oil/ fat category and it has so many nutritional benefits to the human health. However, due to its short supply, particularly in the lean season and comparatively more demand, expensiveness and ghee is prone to adulteration by the unscrupulous traders in the market tend to adulterate ghee with cheaper vegetable oils such as palm oil, coconut oil, sunflower oil. Recently, the problem of adulteration has supposed a very serious dimension. Such a situation has spoiled the quality image of dairy industries. Methods presently adopted by food law enforcing agencies to ensure the quality of ghee are time consuming and costly. In this review latest method-based approaches have been deliberated.

Keywords Adulteration, Vegetable oil, Milk fat.

INTRODUCTION

Ghee has been used in Indian subcontinant since 1500 BC (Achaya 1997). It is the second largest dairy product after the fluid milk. It is reported that approximatetly 35% of the milk is converted into ghee in Indian sub-continent (Hazra *et al*. 2017). At present, ghee market is growing at a CAGR of > 15 % and is probable to reach a value of INR 4653 billion by 2024 (IMARC 2019). Ghee performs an essential function as carrier of four fat-soluble vitamins viz., A, D, E, K and essential fatty-acids such as linolenic acid and arachidonic acid, apart from having rich sensory attributes. The producers/middle-men involved in the ghee trade, tend to adulterate ghee with cheaper vegetable oils such as palm oil, coconut oil, sunflower oil, especially during lean season to earn more money. Recently, the problem of adulteration has assumed a very serious dimension. Reports have been appearing in the print and electronic media, indicating the rampant malpractices of ghee adulteration particularly in the central and northern parts of the country.

It is not known as to what extent these types of malpractices of adulteration are prevailing in the

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ghee trade in our country and what quality of ghee is available to the consumers. In order to ensure a quality product to the consumer, the Government of India has prescribed the compositional standards for milk fat, under FSSR (2011) and AGMARK rules (1981). In this review we have go through various latest methods for detection of vegetable oils adulteration in ghee.

Latest methodology to check the adulteration of milk fat

Based on spectroscopy

Ntakatsane *et al*. (2013) reported the great potential of fluorescence spectroscopy to rapidly discriminate between pure and adulterated milk fat. Fluorescence spectroscopy could detect up to 5% of vegetable oil in butterfat. The pure and adulterated samples were discriminated based on the total concentration of saturated fatty acids, also on the major fluorophores: tryptophan, tocopherols and riboflavin.

Aparnathi *et al*. (2018) developed method i.e. using FT-NIR spectroscopy coupled with chemometric detects the presence of foreign oil in ghee at 2.0% rate and this method can serve as efficient and convenient analytical tool for detection and quantification of foreign oilsin ghee.

(Antony *et al*. 2018) reported FT-MIR spectra of ghee and vegetable oils were acquired using HATR in 4000–650 cm^{-1} region. The differences in absorbance by carbon–hydrogen (C–H) stretch in fatty acid chain at 3.48 lm and absorbance by carbonyl (C–O) stretch of ester linkage at 5.7 lm in ghee and that in vegetable oils were studied. The clear differences in the spectra of ghee and that of the vegetable oils were observed in fingerprint region, which can be very well utilized to develop FT-MIR spectroscopy as a promising tool for detection of vegetable oils adulteration in the ghee.

Based on image analysis:

Wasnik *et al*. (2019) developed a protocol for acquisition and analysis of images of ghee samples to derive mathematical parameters related to adulteration of cow ghee with vegetable fat and to develop a model to forecast the adulteration levels. The images attained using a flatbed scanner were quantified in terms of their pixel intensity, color, morphological, textural and skeleton parameters using Image J software. The selected parameters were measured for images of pure cow ghee sample and compared with that obtained for ghee samples adulterated with 5%, 10%, 15% and 20% vegetable fat. The developed model was successfully validated to classify samples of cow ghee adulterated with vegetable fat to the appropriate level of adulteration (0–20%) with an accuracy >0.85.

Detection of RM- adjuster in ghee

Parul *et al*. (2020) developed a gas chromatography-based technique for detecting RM- adjuster in milk fat. They observed the appearance of large sized signature peaks in the retention time region of 4.5-6.5 minutes for RM-adjuster and adulterant fat, while there was no such type of peaks in the samples of pure cow and pure buffalo ghee. Through this method, the addition of RM-adjusted highly adulterant fat to the minimum level 0.5% could be detected in both cow and buffalo ghee.

Yadav (2020) developed a wash RM protocol for detection of RM adjusted palm oil in cow and buffalo ghee. The pure cow and buffalo ghee adulterated with RM adjusted palm oil (32) @ of 2.5, 5.0, 7.5 and 10.0 %. They concluded that wash RM- protocol for determining the RM- value adjusted ghee the detection limit was found to be minimum 2.5 % level.

Based on e-nose:

Ayari *et al*. (2018) developed electronic nose based on 8 metal oxide semiconductor sensors and detected the adulteration of sunflower oil and cow body fat in cow ghee by olfactory machine system. Therefore, an electronic nose system was used for the different levels of sunflower oil and cow body fat mixed with pure cow ghee (10%, 20%, 30%, 40% and 50%). The principal components analysis and artificial neural networks methods were used to accomplish this goal. Based on the results, the accuracy of the principal components analysis of sunflower oil and cow body fat were 96% and 97% of the data variance, respectively. The results showed, artificial neural networks identified the adulteration with sunflower oil and cow body fat with an accuracy of 91.3% and 82.5% respectively.

Based on Colorimetric methods

Mahendra Kumar (2015) reported that 5% level of vegetable oil in ghee can be easily detected using rapid color-based test. In this test, 1 ml of ghee sample, 2 ml of DPPH (11.41×10^{-5} Mol/l) solution and 3 ml of ethyl acetate as solvent was standardized for checking adulteration of NCT and CT ghee samples with cotton seed oil. If Halphen's test is +ve and if sample reduces DPPH (2 ml of 11.41×10^{-5} Mol/l concentration) i.e., violet color disappears in less than 10 min, presence cotton seed oil as an adulterant is confirmed. If Halphen's test is +ve and if sample does not reduce DPPH within 10 min, it shows absence of cotton seed oil as an adulterant and +ve Halphen's test is solely due to cotton seed feeding practices.

Mahendra Kumar (2015) used ABTS assay for the detection of cotton seed oil adulteration in pure ghee and concluded that it was not able to detect cotton seed oil adulterated ghee samples.

Ramani *et al*. (2018) developed a chromogenic test by taking 1 ml of pure ghee or adulterated ghee (5, 10, 15 and 20 % level of adulteration of palm oil) samples and allowed to react with 2 ml of DPPH solution 50 mg/ 100 ml in ethanol was added and mix it for 30 seconds; thereafter the color change was observed. For pure ghee the color would be violet and for adulterated ghee the color was changed from violet to yellow. The detection level of developed chromogenic test was up to 5% level of palm oil adulteration in ghee.

Sushma *et al*. (2018) reported the colorimetric test by taking about 5 ml of pure home-made ghee and market ghee samples in separate test tubes then the ghee samples were melted using spirit lamp. About 5 ml of Conc HCl was added to each of the samples and observed for a color change after 10-15 mins. For pure ghee no color would be changed and for vegetable oil adulterated ghee the color was changed to red/reddish brown.

Ramani *et al*. (2019) developed a rapid chromogenic method by taking 2 ml of pure ghee or adulterated ghee (5, 10, 15 and 20 % level of adulteration) samples and allowed to react with the chromogenic solution:1 ml of Ferric Chloride solution (0.008 M) was added and there after 0.3 ml Potassium Ferricyanide solution (0.03 M) was added and mix it for 30 seconds; thereafter the color change was observed. For pure ghee the color would be green and for adulterated ghee the color was changed from green to blue. The above protocol was able to detect even 5% level palm oil adulteration in ghee.

Nimbkar and Shanmugasundaram (2019) reported that the addition of soyabean oil to ghee up to a 20% level could easily be detected by using hunter lab.

CONCLUSION

Ghee is a one of the costliest on edible fat category consumed allover India. Therefore, it is highly prone to adulteration with cheaper oils/fats because it is almost five to six time costly than ghee. The detection of vegetable oils/fats in milk fat is a very complicated phenomenon. Wide variation in physico-chemical constants limits their use as such for the detection of adulteration of milk fat. The problem of adulteration has assumed a very serious problem, by adulterating ghee with cheaper oils and fat the unscrupulous traders are not only spoiling their money, but also adversely affecting their health hazard. Several latest methods of oils and fats have been developed to detect the vegetable oils in milk fat. So, researchers are always in-search of latest methods that can solve this problem very easily.

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