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A study on Quality Attributes of Ghee based on packaging materials and storage period

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ABSTRACT
Glass ,Polyethyleneterephthalate(PET), Polypropylene (PP) and High density Polyethylene(HDPE) bottles were filled with ghee, prepared by differently treated cream, under light with little headspace to determine the effects of light ,method of preparation, packaging materials and storage time on the stability of ghee. The moisture content, acid value, peroxide value, refractive index and TBA Value were measured to determine the stability of ghee every 30 days of storage period.. Glass bottles recorded lower oxidation values followed by ghee packed in PET, PP and HDPE. In few cases, PET packaged ghee also showed comparable good results. This study showed that packaging material, method of preparation and storage time has an effect on the stability of ghee.

I. INTRODUCTION

Ghee is a product with very low moisture content; it needs to be protected more from chemical spoilage activated by oxygen, light, humid climates and high temperatures. The presence of oxygen leads to oxidation and formation of hydro peroxides and peroxides and then aldehydes and ketones resulting in off-odours due to rancidity. Another important factor, which contributes to the deterioration of ghee, is moisture. Off-flavours occur due to hydrolytic rancidity. The combination of oxygen and light can create the conditions for some decomposition of the triacylglycerols and production of oxidization products that alters the ghee quality. Quality changes of the ghee may include development of acidity and production of carbonyl compounds (Schieberle and Grosch 1981). Therefore, peroxide concentration gives a measure of degree of oxidative rancidity and serves as an indicator of quality change (Jacobsen 1999; Setiowaty *et al.,* 2000).

The packaging of ghee is of decisive importance. Improperly packaged ghee absorbs foreign odours with which, it may come in contact. Physical characteristics of the packaging material (permeability and light transmittance) may directly affect the quality of ghee (Hotchkiss. 1995). Glass, metals and different kinds of plastic films (bottles) are all used for packaging of ghee. The packaging material should have good water vapour and oxygen barrier properties. Glass has many advantages such as inertness and rigidity, but it is costly and brittle. Plastic bottles are used extensively for packing due to their outstanding function.PET is becoming a popular plastic because of its excellent barrier appearance, mechanical properties low weight and price. Ghee need special type of durable and leak proof packaging, as they are semi-liquid in nature. Excellent quality ghee and oil packaging products help not only in preventing the leakage but also keep the products fresh and free from bacteria and germs for long length of time (Archana, 1997).

It is extremely important that, whatever packaging material used for ghee, it should be food grade and non-toxic. HDPE bottles, PP laminates, Polymer coated cellophane, nylon-6 polymer or food grade PVC and their laminates, glass bottles, PET bottles, PP bottles need to be effectively tapped for packing of ghee. Glass bottles provide excellent protection for ghee and can also be used for high speed operation. Glass is one of the most inert materials for bottles. HDPE bottles provide a moderately long shelf-life, are light in weight. PET bottles have excellent clarity, are odour-free and have good gas barrier properties.PET bottles are also accepted internationally for ghee packaging. Storage stability and shelf life of packaged oils/ghee are now receiving much attention. The present study was conducted to evaluate the suitability of different packaging materials for the preservation of ghee.

II. Materials and Methods

The samples of fresh cream after separation of buffalo milk were procured from Dairy plant, KeraIa Veterinary and Animal Sciences University, Mannuthy. The collected cream samples were analysed for its fat using gerber method and acidity by titration to assess the suitability for further processing. The sample was subjected to two treatments. To one batch of cream 1% lactic starter was added followed by overnight incubation while the other lot was treated as fresh cream. The ghee was prepared from both lots using direct cream method suggested by Mishra and Kushwaha, (1970).

The prepared ghee was packed into different packaging materials. The packaging materials selected were glass, Poly propylene (PP), High Density Poly ethylene (HDPE) and Polyethylene Terephthalate(PET) . The sample was packed in duplicate and kept for storage at room temperature (31°c) for 60 days. The different quality parameters of ghee was analysed as per standard methods (SP: 18(PART XI- 1981) on storage at 0^{th} day, 30^{th} day and 60^{th} day.

Free fatty acids

Free fatty acids were determined by titration according to the standard method at the specified intervals and expresses as percentage oleic acid.

Peroxide value

This method determines all substances in terms of milliequivalents of peroxide per 1000g of sample (meq O_2/kg) which oxidise potassium iodide (AOCS 2004)

Refractive index

Refractive index of ghee was determined by using butyro refractometer.The butyro refractometer reading at 40°C was measured.

Thiobarbituric acid (TBA) value

Standard method was used for determining the TBA value of ghee. The ghee was dissolved in CCl_4 and TBA reagent. The spectrophometric reading of final sample was taken at 530 nm.

Data analysis

Data were analyzed by using standard staticical procedures using indexes such as mean and standard deviation.

Results and Discussion

The effects of packaging material, storage time and method of manufacture on different measured properties on ghee were determined. The different packaging material caused different effects on the keeping quality of ghee upon storage.

Free fatty acids

The mean values of FFA content indicate that there are significant increase in free fatty acid content between initial and final day of storage at different storage conditions (Table 1.). During storage FFA% of all ghee samples exhibited similar increasing trends irrespective of the packaging material and type of manufacture. The results in Table 1 agree with those of Kicuk and Caner (2005), where all the oil samples prepared and packed in glass and PET containers showed increase in free fatty acid content during storage and this may be due to the partial hydrolysis of oil/ghee during storage. These results also are in agreement with the results obtained by Patterson (1992) wherealso the oil samples showed an increase in free fatty acid content. The change in FFA content with storage time was significant at 5% level but with packing materials the change was not significant. A study by Mishra and Sharma (2011) also showed an increase in FFA content of rice bran oil samples packed in glass, PET and laminates during storage. In practice, because of the susceptibility of the oil to hydrolysis, the FFA content may vary with age and storage history (Semwal and Arya, 2001).

	Fresh Cream			Cultured cream		
Material	Mean	Std. Deviation	P value	Mean	Std. Deviation	P value
Glass	.427033	.0354824	0.211	.435967	.0242780	0.155
PET	.426700	.0279548		.438933	.0286381	
HDPE	.449100	.0397091		.445900	.0288595	
Polypropylene	.438700	.0440571		.457233	.0320275	
0 day	.406000	.0000000	0.001*	.422100	.0000000	0.001*
30 day	.425275	.0220043		.436725	.0200701	
60 day	.474875	.0140981		.474700	.0088446	

*significant at 5% level of significance

Table 1. Effect of packaging materials and storage time on mean freefatty acid values

Peroxide Values

The amount of Peroxide values showed significant increases in ghee stored in different packaging material from starting point to 60 days (Table 2). A study conducted by Kucuk and Caner(2005) showed a similar result by showing significant increases in oil stored in different packaging material from starting point to 3, 6 and 9 months. The Polenskey value by the ghee samples showed minimum for glass bottles followed by PET, HDPE and Polypropylene eventhough the change was not significant with packaging materials. The quality of any fat

or oil is highly affected by the ability of the container to exclude light and oxygen, which further retards oxidative changes. Mishra and Sharma (2011) found out that ghee packed in PET bottles showed higher increase in PV compared to those packed in glass containers. PV was greatly dependent on storage temperature (Dong and Jong, 1998).

Material	Mean	Std. Deviation	P value	Mean	Std. Deviation	P value
Glass	.3133	.01528	0.083	.3133	.01528	0.113
PET	.3233	.02517		.3233	.02517	
HDPE	.3533	.05033		.3733	.07024	
Polypropylene	.3400	.04000		.3600	.06557	
0 day	.3000	.00000	0.004*	.3000	.00000	0.014*
30 day	.3325	.02217		.3400	.03162	
60 day	.3650	.03109		.3875	.05560	

*significant at 5% level of significance

Table 2. Effect of packaging materials and storage time on mean peroxide values

Refractive index

The RI of ghee sample prepared from fresh cream packed in different containers showed a gradual increase from initial day to sixtieth day. The mean RI values of ghee packed in glass bottles and PET bottles showed least increase after 60 days (Table 3).The mean value of increase in RI was from 1.4553 to 1.4554(° Brix). The ghee packed in HDPE Bottles showed higher increase in RI compared to other packaging materials. The ghee prepared from cultured cream also showed similar pattern of increase in RI. A study conducted by Arya *et al., (*1969) to evaluate the possibility of considering Refractive index as a tool for checking rancidity showed that there was an increase in refractive indices of edible oils and fats in the order of 0.001±0.0003 at the stage of development of perceptible rancid odour. The increase in value was from 1.4775 at initial hour to 1.4779 after 24 hours. The increase in refractive index is possibly attributable to conjugation known to precede hydro peroxide formation in the secondary stage, and polymerization of partially oxidized fats in the tertiary state of auto oxidation.

	Fresh cream			Cultured cream		
Material	Mean	Std. Deviation	P value	Mean	Std. Deviation	P value
Glass	1.455400	.0001732	0.247	1.455400	.0001000	0.189
PET	1.455467	.0002082		1.455467	.0001528	
HDPE	1.455733	.0005859		1.455533	.0002082	
Polypropylene	1.455600	.0003606		1.455533	.0002517	
0 day	1.455300	.0000000	0.008*	1.455300	.0000000	0.002*
30 day	1.455425	.0000957		1.455500	.0000816	
60 day	1.455925	.0003594		1.455650	.0001291	

*significant at 5% level of significance

Table 3. Effect of packaging materials and storage time on mean Refractive index values

TBA value

TBA value which is an indication of secondary oxidative aldehyde products also showed increase in values during storage. TBA values of ghee prepared from fresh cream and cultured cream showed increase in TBA value (Table 4) when the storage period increases. This results confirms the earlier results that auto oxidation increases during storage. In this case also ghee packed in glass containers showed less change compared to other packaging materials.

	Fresh cream			Cultured cream		
Material	Mean	Std. Deviation	P value	Mean	Std. Deviation	P value
Glass	.183667	.1778942	0.217	.377000	.2616429	0.092
PET	.192000	.1880771		.460333	.3349483	
HDPE	.354667	.3651265		.553667	.4218179	
Polypropylene	.294667	.3421788		.500333	.3693918	
0 day	.076000	.0000000	0.001*	.076000	.0000000	<0.001*
30 day	.129000	.0623806		.626250	.0898494	
60 day	.563750	.1931241		.716250	.1349923	

*significant at 5% level of significance

Table 4. Effect of packaging materials and storage time on mean TBA values

Conclusion

Increasing the storage time had an adverse effect on peroxide value, moisture, acid value, refractive index and TBA Value. The difference of the increase of those values in different packaging materials could be explained by (1) The absorption of light into packaging materials; and (2) the degradation of ghee compounds due to the initial oxygen concentration and permeability of oxygen through the package. Ghee stored in glass bottles showed very low oxidation and maintained its original profile for a long period. This was followed by ghee packed in PET, PP and HDPE containers.This study has shown that ghee is affected by light and oxygen in much the same way as other vegetable fats and oils. This study also reaffirmed that the glass provides better protection from oxidation than plastic bottles.

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