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Effect of sunlight on quality and stability of dietary oils and fats

Muhammad Sohail[1], Taufiq Ahmed[2], Saeed Akhtar[3] and Yasser Durrani[3]*

[1]Department of Food Science and Technology, NWFP Agricultural University, Peshawar, Pakistan
[2]Nuclear Institute for Food and Agricultural (NIFA), Tarnab, Peshawar, Pakistan
[3]Food Biochemistry Section, PCSIR Labs Complex, Peshawar, Pakistan

Abstract: The present study was conducted to evaluate nine oil and fat samples i.e. animal fat (A.F), vanaspati ghee (V.G), sunflower oil (SFO), canola oil (Can.O), desi ghee (D.G), rapeseed oil (RPS), soybean oil (SBO), sea buckthorn seed oil (S.B.Seed) and sea buckthorn pulp oil (S.B.Pulp) for their quality and stability under sunlight condition. The quality of samples was determined in terms of peroxide value (POV), free fatty acid (FFA), beta-carotene content and colour (O.D) at the start of five weeks experiment followed by weekly analysis. The maximum POV increase was found for V.G (7040.48 %) and minimum increase was found for S.B.Seed oil (195.43 %). The maximum FFA increase was found in SFO (545.45 %) while the minimum increase was found in R.P.S (34.33%). The maximum decrease of beta-carotene was found in SFO (98.78 %) while the minimum decrease was found in desi ghee (62.91%). The maximum reduction in O.D was found for canola oil (84.91 %) whereas the minimum decrease was found in SFO (62.5%). Results indicated that light affected the dietary oils and fats very much therefore great care should be taken during their storage in order to avoid them from rancidity.

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***Author for Correspondence:** msohail294@yahoo.com

INTRODUCTION

Fats and oils belong to the group of naturally occurring substances consisting of fatty acids and other substances. They are considered concentrated source of energy for human beings. From commercial point of view, they are often used in manufacturing of several industrial products commonly used in daily life like soaps, cosmetics, detergents, greases and paints etc[1].

Edible oils play a vital role in the economy of many countries especially Pakistan, which is facing serious shortage of edible oils. The domestic production meets only one third of the requirements, while two third are imported[2]. One of the major problems in fats and oils is the development of rancidity (oxidation) and deterioration of its quality due to multiple environmental and storage conditions. The oxidative deterioration of dietary oils and fats is a complex process, leading to produce various decomposition products[3]. Oxidation is said to be the off flavour quality of food. Rancid off flavours are concerned with the changes, which result from reactions with atmospheric oxygen[4].

All fresh foods including oils and fats have distinct characteristic flavours, which are normally recognized by consumers. This is particularly true in edible oils packaged in clear glass containers (5). The oxidised oils not only deteriorate the taste of foods to which they are added but are considered to create many health problems i.e. diarrhea, poor rate of growth etc[6,7]. Consumers are now becoming increasingly conscious of nutritional value of their food and its ingredients[8].

Light plays an important role in quality and stability of edible oils, fats and fat containing products irrespective of their origin. The action of light has long been known to cause rancidity of oils, fats and fat containing products[9].

The oil industry is one of the most important food industries that need great attention during processing, transportation, handling and storage of products. This problem is becoming increasingly serious due to the exposure of edible oils (placed in transparent bottles) to intensive sunlight through out the year. The objective of this study is to evaluate commonly consumed dietary oils and fats for quality and stability under sunlight condition.

MATERIALS AND METHODS

There were nine oil and fat samples i.e. Animal fat (A.F), Vanaspati ghee (V.G), Sunflower oil (SFO), Canola oil (Can.O), Desi ghee (D.G), Rapeseed oil (RPS), Soybean oil (SBO), Sea buckthorn seed oil (S.B.Seed) and Sea buckthorn Pulp Oil (S.B.Pulp). They were procured from the local market of Peshawar and analysed for their quality and stability in Nutrition Lab of Nuclear Institute for Food and Agriculture (NIFA) Tarnab, Peshawar.

Photo oxidation studies (sunlight condition)

Samples were kept in 100 ml glass beakers covered with muslin cloth. All the glass (Pyrex type) including beakers was chemically cleaned to avoid any contamination of heavy metals etc. For each set of experiment an equal amount of oils and fats was taken to maintain a uniform surface area.

Chemical analysis

The quality of samples was measured by determining the selected quality parameters, Such as per oxide value (POV), free fatty acid (FFA), beta carotene content and colour as an optical density. POV was determined by using recommended method[10]. While beta-carotene was determined at 446 nm, colour (optical density) at 420 nm using Shimadzu Spectrophotometer model 160[11] and FFA was determined using recommended method[12] at the start of five weeks experiment followed by weekly analysis.

Statistical analysis

All the data were statistically analyzed by analysis of variance using randomized complete block design[13].

RESULTS AND DISCUSSION

Oil and fats are very prone to deterioration during processing, transportation, marketing and storage under various conditions, and as a result they become rancid. Therefore the present study was carried out to determine the extent of oxidative deterioration of selected oils and fats under sunlight condition.

Peroxide value (POV)

The data of peroxide value (POV) of nine oil/ fat samples exposed to sunlight condition are shown in figure I, which is significant at 5% level of significance. The peroxide values of samples were in the range of 2.52 and 186.09 meq/kg. Results indicate that the peroxide values increased with the passage of time, which is also proved in a previous work[14] stating that the principal route of deterioration of oil is through rancidity, resulting from oxidation. The maximum increase was found in V.G (7040.48 %) while the minimum increase was found in S.B.Seed oil (195.43%).

The peroxide value of A.F., V.G., SFO, Can.O, D.G., RPS, SBO, S.B.Seed oil and S.B.Pulp oil in the beginning of experiment was 9.04, 2.52, 5.32, 12.34, 3.58, 24.39, 5.99, 62.99 and 35.49 meq/kg respectively. While at the end of experiment the peroxide values increased to136.78, 179.94, 110.54, 113.25, 126.51, 98.98, 171.69, 186.09, 217.35 meq/kg respectively. A high POV indicates that the product has a high rancidity potential and could fail on the shelf[15].

Free fatty acid (%)

The result of FFA % of nine oil/fat samples exposed to sunlight condition is shown in figure II. Free fatty acid values increased gradually as the exposed time to light was increased. Statistical analysis shows that the free fatty acid values are highly significant at 1% level of probability ($p<0.01$). The free fatty acid values of samples were in the range of 0.11 % and 19.37 %. The maximum increase was found in SFO (545.45 %) while the minimum increase was found in R.P.S (34.33%).

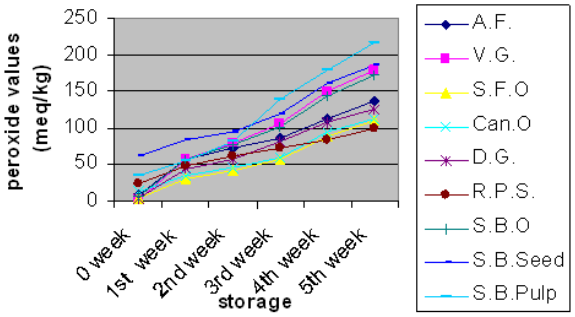

Figure 1: Effect of sunlight on the peroxide values (meq/kg) of oil and fats.

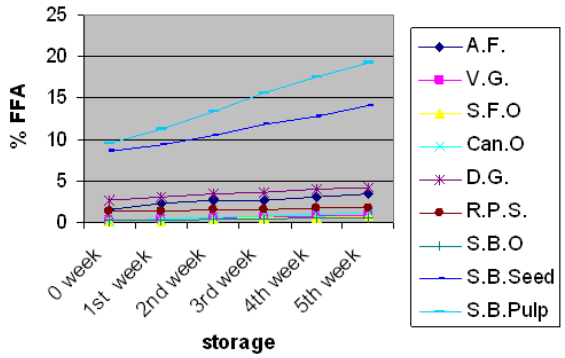

Figure 2: Effect of sunlight on the % free fatty acid values of oil and fats.

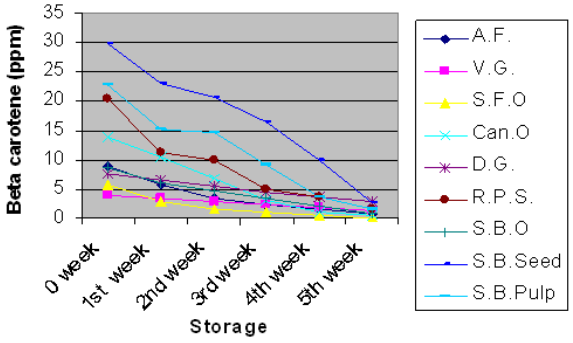

Figure 3: Effect of sunlight on the Beta carotene (ppm) content of oil and fats.

RPS, SBO, S.B.Seed oil and S.B.Pulp oil at the start of experiment was 1.6, 0.24, 0.11, 0.22, 2.72, 1.34, 0.12, 8.62 and 9.61% respectively. While at the end of five weeks study these values reached to 3.39, 0.77, 0.71, 1.19, 4.29, 1.80, 0.61, 14.10 and 19.37% respectively. In fat deterioration the first initiating step is the formation of fatty free radicals, which are susceptible to oxygen's attack in the presence of

light, resulting in formation of many organic compounds and free fatty acids[15].

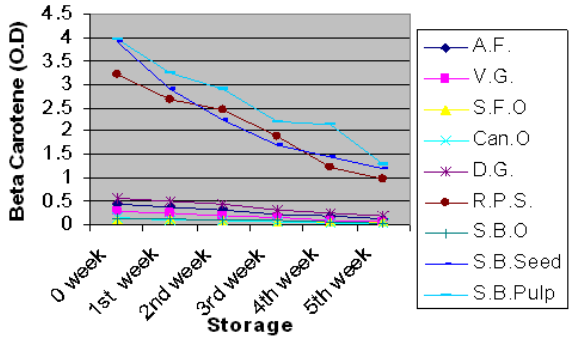

Figure 4: Effect of sunlight on the color (optical density) of oil and fats.

Beta-carotene content

The data on beta-carotene content of nine oil and fat samples exposed to sunlight condition are shown in figure III. Results show that the beta-carotene values gradually decreased with the passage of time and were highly significant at probability level of 1% due to the effect of sunlight. The beta-carotene content of samples was in the range of 29.73 ppm and 0.07 ppm. The maximum decrease was found in SFO (98.78 %) while the minimum decrease was found in desi ghee (62.91%).

The initial beta-carotene content of A.F., V.G., SFO, Can.O, D.G., RPS, SBO, S.B.Seed oil and S.B.Pulp oil was 8.97, 3.94, 5.72, 13.83, 7.55, 20.25, 8.75, 29.73 and 22.80 ppm respectively. When the five weeks study was reached to an end these values decreased to 0.66, 1.42, 0.07, 0.53, 2.80, 1.60, 0.89, 2.68 and 1.59 ppm respectively under sunlight condition.

Color (optical density)

The result of optical density of nine oil and fat samples exposed to sunlight condition are shown in figure IV. The optical density values decreased gradually as the exposed time to sunlight was increased. The colour (O.D) values of samples were in the range of 0.128 and 1.30. The maximum decrease was found in Canola Oil (84.91 %) whereas the minimum decrease was found in SFO (62.5%). In the beginning the colour (O.D) of A.F., V.G., SFO, Can.O, D.G., RPS, SBO, S. B. Seed oil and S. B. Pulp oil was noted as 0.453, 0.281, 0.136, 0.159, 0.557, 3.2, 0.128, 3.90 and 3.96 respectively. Due to the effect of sunlight the initial values deceased to 0.139, 0.053, 0.051, 0.024, 0.187, 0.99, 0.045, 1.19 and 1.30 respectively.

CONCLUSION

In the view of the results obtained we can conclude that rancidity of oil and fats increases under sunlight conditions and hence these dietary oils and fats should be protected from sunlight.

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