International Journal of Science, Environment and Technology, Vol. 5, No 4, 2016, 2557 – 2565

ISSN 2278-3687 (O)
2277-663X (P)

FORTIFICATION OF OMEGA-3 FATTY ACIDS IN PROCESSED CHEESE SPREAD

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Abstract: The aim of this paper was to optimize the level of fortification of omega-3 fatty acid into processed cheese spread. The fortification level of 5 to 15% with 5% interval with flaxseed oil, algal oil and fish oil emulsions were incorporated into processed cheese spreads.15% of fortification level was selected for flaxseed oil and algal oil and 10% was selected for fish oil emulsion based on sensory evaluation. The storage study was carried out at 5°C for 90 days. During storage studies, the samples showed slightly decreased sensory scores with increase in storage periods but, within acceptable limit. The physicochemical parameters viz., pH, titratable acidity, chemical composition and microbial parameters viz., total viable count, coliform count, yeast and mould counts of fortified processed cheese spreads were analyzed. Based on the results, it was found that, there was decrease in pH and increase in titratable acidity and total viable counts during the storage period.
Keywords: Processed cheese spread, flaxseed oil, algal oil, fish oil, oxidative stability.

1. INTRODUCTION

Omega-3 fatty acids (n-3 FAs) are a group of polyunsaturated fatty acids (PUFA) which include α-linolenic acid (ALA, C18:3 n-3), its long chain metabolites eicosapentaenoic acid (EPA, C20:5 n-3) and docosahexaenoic acid (DHA, C 22:6 n-3) (Simopoulos, 2002). There is increasing evidence on the importance of these essential fatty acids in relation to human health and disease prevention such as cardiovascular diseases, hypertension, diabetes, arthritis, inflammatory diseases and autoimmune disorders (Calder, 2006; Gogus and Smith, 2010). Increased knowledge of the health benefits of omega-3 fatty acids especially EPA and DHA has directed to an emergent demand for products rich in omega-3 fatty acids. These products represent one of the fastest developing trends in the food industry which has opened up new era for functional foods (Ganesan*et al.* 2014).

Dietary recommendations for omega-3 fatty acids can be obtained from the diet by the consumption of foods rich in these fatty acids (Gebauer*et al.,* 2006). According to Joint WHO / FAO 2010, the daily recommended intake of omega-3 fatty acids should be at least 250mg/day for healthy life. The consumption level of omega-3 fatty acids acid in many

*Received July 23, 2016 * Published Aug 2, 2016 * www.ijset.net*

countries is far below the recommended level which indicates deficient in consumption level of omega-3 fatty acids and it suggest that there is an urgent need to include the omega-3 fatty acids in their diet (Kolanowski *et al.,* 2005).

Fortification of commonly consumed food products with omega-3 fatty acids is considered as an innovative way of providing the health benefits to people without major alteration in their dietary habits (Garg *et al.,* 2006). The effort to incorporate fish oil directly into food formulations always a challenging task mainly because the "fishy" flavours revealed from final food products (Anbudhasan *et al.,*2014). Oil-in-water emulsions may be a more effective method to deliver omega-3 fatty acids into functional foods (Djordjevic *et al.,*2004).Dairy products, such as cheese and butter, have been shown to be good delivery systems for elevated levels of omega-3 fatty acids. (Kolanowski and Weißbrodt *et al.,* 2007)

The main aim of selecting processed cheese spread (PCS) provide suitability for proper mixing of oil emulsion and with increased shelf life compare than other cheese products.This research work focuses on solving sensory issues by optimizing level of omega-3 fatty acids.

2. MATERIALS AND METHODS

Materials

Cheddar cheese was purchased from local market. The omega-3 oils such as flaxseed oil purchased from local market, algal oil purchased from Aamruth Industries, Bangalor and the fish oil purchased from Arjuna-Naturals Extracts ltd., Coimbatore. Whey protein concentrate was purchased from Hale and health pvt.ltd., Chennai.

2.1.1. Preparation of Processed Cheese spread

The Processed Cheese spread was prepared as per the procedure outlined by David (2008). Cheddar cheese at different age group (0-12 month) was used for the preparation of processed cheese spread. The 30-40% of ripen cheese (9-12 months), 20-30% of semi ripen cheese (4-6 months) and 30-40% of unripen cheese (0-1 month) were shredded and added with salt (2-3%), sodium citrate (5%), sodium phosphate (5%) and flavor (0.05%). 10% of cream was added to adjust the fat. All ingredients were blended in Stephan kettle and heated at 80-85°C for 20 minutes. It was stored at 5°C.

2.1.2. Preparation of emulsion

The 1000ml of sterile water was added with 10g of whey protein concentrate and pre-homogenized at 7000rpm for 3min using ultra-turrax homogenizer. The 100ml of oil was slowly added into it and pre-homogenization continued for 2minutes. Then the pre-homogenized emulsion was passed through the microfluidizer thrice at 15,000psi.

2.1.3. Omega-3 fatty acid fortified PCS preparation

The emulsion at the level of 5 to25% with 5% interval level of flaxseed, algal oil and fish oil emulsion was individually added into 100g of PCS prior to packaging. The sterilized Poly Propylene container was used as storage container.

2.1.4. Physicochemical properties analysis

Control processed cheese spreads and different types of Omega-3 fatty acids fortified processed cheese spreads were prepared and analysed for physicochemical parameters viz. pH, titratable acidity, moisture, ether free extract, crude protein, nitrogen free extract, crude fibre and total ash as per the standard procedures described in AOAC, 18th Edition, 2006.

2.1.5. Microbiological analysis

Microbiological analysis viz. standard plate count, coliform count and yeast and mould count for control processed cheese spread and different types of Omega-3 fatty acids fortified processed cheese spread were carried out as per the standard procedure described in in BIS: 1981. The analysis was carried out periodically during storage up to 90 days.

2.1.6. Estimation of Omega-3 fatty acids

The quantity of omega-3 fatty acids asecosapentanoic acid, decosahexanoic acid and alpha linolenic acid in three different omega-3 fatty acid enriched cheese spreads at 90th day were quantified by gas chromatography mass spectrometer (GC-MS).

2.1.7. Statistical analysis

The data were tabulated and subjected to statistical analysis performed using IBM SPSS® 20.0 for Windows®.

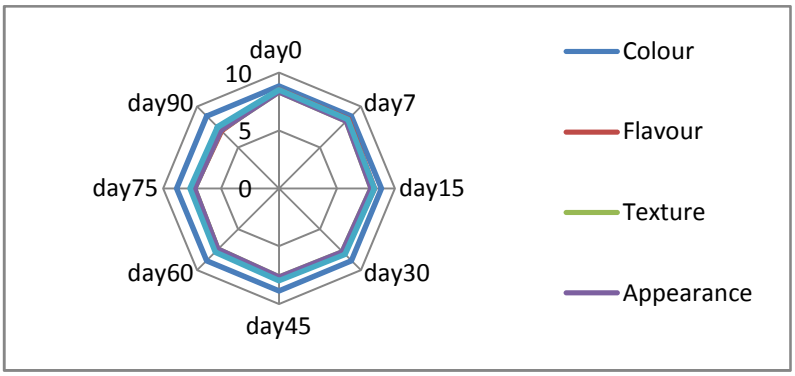
3. RESULTS AND DISCUSSION

3.1. Sensory analysis

PCS without flavour (Plain PCS) as well as with garlic and pepper flavour were taken as base material. The flaxseed, algal and fish oil emulsion was individually incorporated in to PCS at the level of 5, 10, 15, 20 and 25% with 5% interval. The fortification level was standardized based on sensory score. The fortification level of 15% was selected for flaxseed and algal oil. In case of fish oil emulsion 10% fortification level was preferred by the sensory panel. The fortification level was not increased by the addition of flavours in PCS. The fortification level is same for PCS with and without flavour. In contrary to Kolanowski and Weixbrodt, (2007) who stated that the flavoured dairy product may help to mask the undesirable odour of fish oil which leads to increase in incorporation level. It was noted that the addition of omega-3 fatty acids was not affects the colour of cheese which was close accordance with the observations

of Hejazian *et al.* (2014) who revealed that the additions of microencapsulated Kilka oil (omega-3 source) to cheese didn't affect the colour of produced cheeses. The addition of omega-3 oil in the form of emulsion aided to mask the undesirable flavour and prevents oxidation. At the same time addition of emulsion affects the texture of PCS which was supported by Horn 2012. It was concluded that the sensory score was decreased with increase in level of added emulsion.

Fig. 1 Comparison of day-wise sensory scores of flaxseed oil fortified PCS



3.2. Sensory analysis during storage at 5°C

The sensory score of PCS individually fortified with 15% flaxseed oil, 15% algal oil and 10% fish oil emulsion were observed and presented in fig 1, 2 and 3.

Fig. 2 Comparison of day-wise sensory scores of algal oil fortified PCS

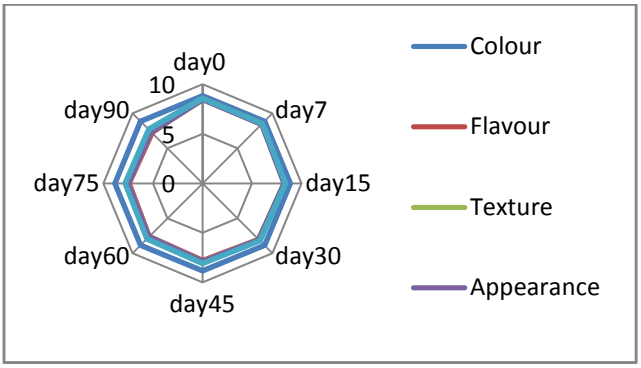
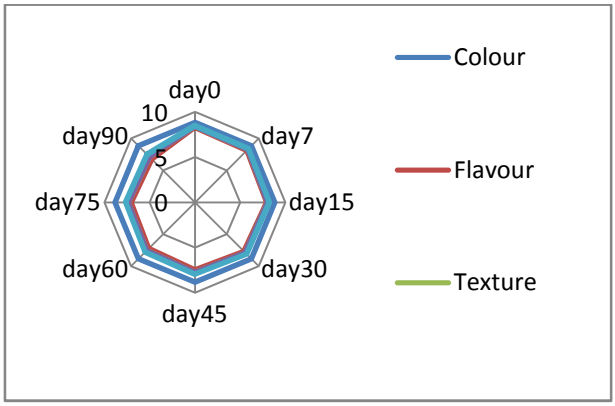


Fig. 3 Comparison of day-wise sensory scores of fish oil fortified PCS



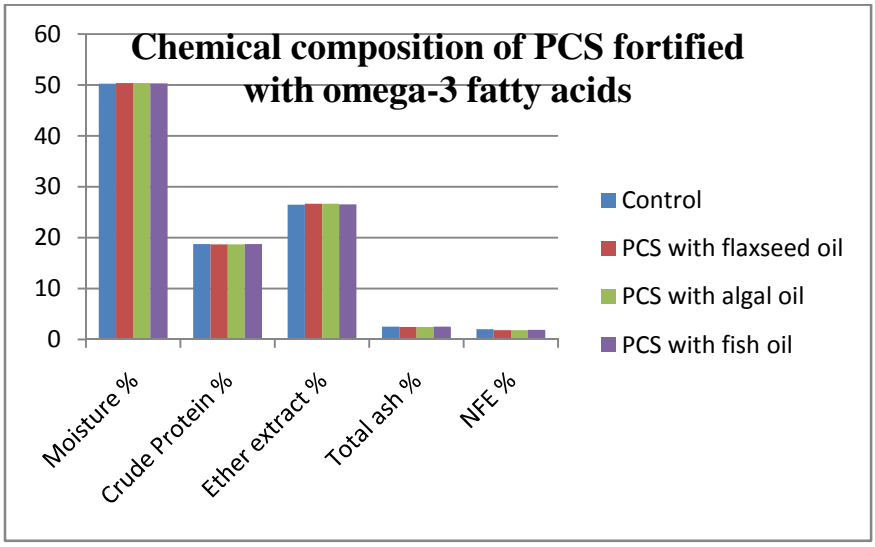
The sensory score was decreased with increase in storage. Statistically there was a highly significant difference within the treatment group. The colour score was remains constant during storage. The flavour score was decreased with increase in storage it couldbe due to increase in oxidation. This reason was stated by Horn, (2012) who stated that the sensory quality of fish oil enriched cream cheese was significantly impacted by the oxidation during a 20 weeks storage period. The texture and appearance scores shows falling tendency during storage. This may possibly due to moisture loss during storage. Decrease in pH may increase the hardness during storage which may reduce the texture as well as appearance score. This reason was supported by Kycia *et al.*(2006) who stated that increase in hardness accompanied by decrease in pH. The overall acceptability for all three OPCS was within favourable limit during storage period.

3.3. Physicochemical analyses during storage at 5°C

The pH values were showing declining trend during storage as increase in titratable acidity throughout the storage period. The reason may owe to increase in total plate count.

The pH value for control was lesser than OPCS which may due to addition of emulsion. The pH value of control was ranged from 5.88 to 5.64 and the titratable acidity was ranged from 0.08 to 0.16. The pH value of omega-3 PCS was ranged from 5.97 to 5.65 and the titratableacidity was ranged from 0.05 to 0.13. This pH range was correlated with Hamad and Ismail (2009) who observed the effects on the properties of processed cheese spread by increasing the amount of added water into the ingredients and the pH was ranged from 5.96 to 5.59 during storage of 3 months at 7±2°C.

Fig. 4 Chemical composition of PCS fortified with selected levels of omega-3 fatty acids



Statistical analysis revealed a high significant difference within the treatment group. Compare than control other cheese samples shows an important variation in moisture. A possible explanation for the increased moisture of omega-3 fatty acids fortified cheese could be related to the addition of emulsion. The moisture content of 10% fish oil fortified PCS was lesser than other two which is added at the level of 15%. The ether extract of omega-3fatty acids fortified cheese having slightly higher value than control sample which may due to the addition of oil. The cheese showed minor variations in these characteristics compared to control the same behaviour was observed in all three OPCS.

3.4. Microbial growth during storage

Storage life of the studied cheeses was evaluated with microbial counts conducted for each cheese. All samples were stored under refrigerated conditions (5°C) and microbial analysis was conducted up to 3months. The standard plate count of all cheese was increasing with increasing in storage days. It was ranged from 1.24 to 1.84logcfu. Although the emulsion was prepared under sterile condition and the cheese samples were stored in sterile container, the counts were slightly increased compare than control which was ranged from 1.37 to 1.84 log cfu. It was important noted that there was no presence of yeast and mould throughout the storage days. This result was similar to the findings of Hamad and Ismail (2009).Statistical analysis has shown a highly significant difference ($P \leq 0.01$) within the treatment.

3.5. Omega-3 quantification

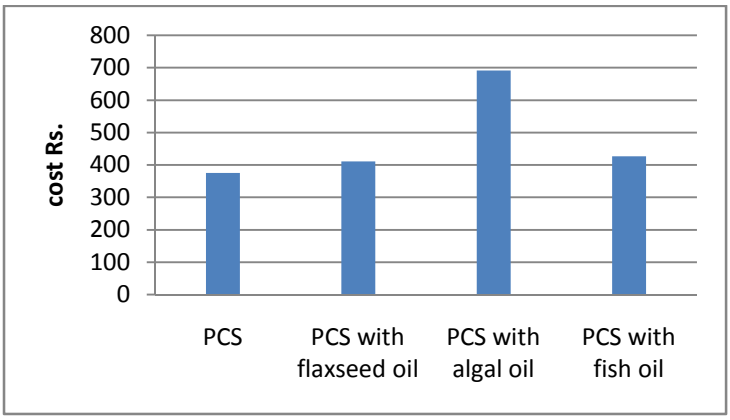
Final concentration of omega-3 FAs at 90^{th} day is shown Table. The omega-3 FAs fortified PCS were quantified by using GC-MS. It is important to mention that the control sample did not have omega-3.It is very clear that the retention of emulsified flaxseed oilis better in the

cheese matrix than in fish oil. The quantity of omega-3 fatty acid in PCS individually fortified with 15% flaxseed oil in the form of ALA was 0.848g in 100g which was more than other two sources. The 15% algal oil added PCS contains 0.532g in 100g was lesser than 10% fish oil emulsions added PCS (0.550g/100g). The recovery of PCS individually fortified with 15% flaxseed oil, 15% algal oil and 10% fish oil emulsions at 90thday were 94.22, 93.33 and 91.66%. This poor retention could be explained bythe passage of emulsion through microfluidizer.

3.6. Cost of production

The cost of omega-3 fatty acids fortified PCS was higher than control PCS which are presented in fig. 5. Apart from the cheese preparation equipment, microfluidizer was needed for emulsion preparation which cost around Rs.25 lakhs. The cost of OPCS was depending upon the oil used for fortification.

Fig. 5 Comparison of production cost of control and PCS fortified with omega-3 fatty acids



4. Conclusion

The results obtained from statistical analysis the best fortification level were 15 % for algal, flaxseed and 10% for fish oil emulsion. The statistical analysis revealed a high significant difference during the storage period for all sample in sensory, pH, titratable acidity and SPC counts. It was observed that there was no presence of E.coli and yeast and mould during the storage period. The change in values during the storage period was within the acceptable limit. Although the omega-3 quantity was higher in flaxseed oil fortified PCS, the conversion is needed to yield EPA and DHA which might be approximately 10% level. The cost of omega-3 PCS was higher than control PCS.

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