FORTIFICATION OF ORANGE PEEL POWDER IN VERMICELLI: A REVIEW

Deeksha Rawat

Department of Food Technology and Nutrition, School of Agriculture, Lovely Professional University, Phagwara, 144411, India

Abstract

In the growing world, the need and demand for food increasing day by day and causes micronutrient deficiencies. Fortification of food aims to prevent deficiency in the population or specific group of population. Extrusion cooking is a widely used processing technique in the growing world for food industries as it is considered to be an efficient manufacturing process. Vermicelli is a popular instant food product. It is categorized under the category of extruded products and is made from semolina. Vermicelli which is made from semolina and water it contains a low amount of dietary fiber and vitamin C so for increasing the amount of vitamin C and dietary fiber we use orange peel.

Keywords; fortification, vermicelli, orange peel

1)Introduction

The impacts of micronutrient deficiencies are devastating for people, families, and full countries. Poor diet and limited access to nutritious foods are among the key reasons why someone may lack crucial micronutrients for human development like iron, vitamin Bc, vitamin A, and iodine. Within the growing world, the demand for food increases day by day with the rise within the world population (Hall et al., 2009). It is difficult to meet the desired essential nutrient from the traditional diet (Abeshu et al. 2016). Therefore, food fortification is one of the processes for the growing world to satisfy the suitable daily intake from the diet (Dary et al., 2006). Food fortification is the supplementation or addition of one or more components in food to improve the properties of food (Huma et al., 2007; Smoliner et al., 2008). Food fortification aims to prevent or correcting a demonstrated deficiency in the population or specific group of population (Darnton and Nalubola., 2002). Firstly, fortification of food was done in the United States in 1924, when iodine was voluntarily added to the normal salt to reduce the incidence of endemic goiter (Ershow et al., 2018). There are several methods for fortification such as Mass fortification, targeted fortification, bio Fortification (i.e., breeding crops to extend their nutritional value –conventional selective breeding and modern genetic modification), synthetic Biology (i.e., the addition of probiotic bacteria to foods) (Gómez et al., 2010). Extrusion cooking is the most important technique for new and extinct processed food in the food industries (Anton et al., 2009; Chemat et al., 2011). Extrusion cooking is consist of several unit operations i.e Mixing, frying, shearing, puffing, final forming, and drying in one energy-efficient, fast and continuous cycle which can be used to produce a wide variety of starchy foods, including snacks, ready for use. to eat (RTE) cereals, confectioneries and extruded crispbreads (Riaz and M.N., 2019; Cheftel, J. C., 1986**).** The cold extrusion process is carried out at room temperature or marginally elevated temperature (Boyaci et al., 2012). In the extrusion process, the sample is extruded without frying or coloring the food. The extruder has a deep-flighted screw, which operates at a low speed in a smooth barrel, to knead and extrude the material with little friction (Harper., 2019). It is used to produce pasta, vermicelli, hot dogs, pastry doughs, and some types of confectionery (Best and E.T., 1994).

2)Vermicelli

Figure 1: Vermicelli

Vermicelli is made out of semolina (Figure 1). It is simply semolina and water. Vermicelli is a popular instant food product. It falls under the category of extruded product and is made from semolina (Lorusso and A. V.., 2015). Thatswhy, it is high in proteins and liked by society from all walks of life, irrespective of age. It is one of the most preferred ready to cook an item in both Indian and foreign markets. With the rapid urbanization and growth of the economy, the demand for healthy and easy to prepare food products has reached sky-high (Krishnan et al., 2012). This makes the vermicelli making the business an ideal business opportunity to grab on as the demand for the same is in a highly growing trend (as shown in table 1) vermicelli contains have a low amount of dietary fiber and vitamin c (Choo et al., 2010).

Table 1: Nutritional values of Vermicelli (approx per 100 g)

Nutritional values	per 100G
Energy	381kcal
Proteins	10.5g
Total Carbohydrates	82.5g
Dietary fiber	2.5g
Total fat	1g
Saturated fatty acid	0.2g
Polyunsaturated fatty acid	0.6g
Monounsaturated fatty acid	0.1g
Trans-fatty acid	0g
Sodium	0g
Cholesterol	0mg
Calcium	3mg
Iron	3mg
Vitamin A	0mg
Vitamin C	0mg

3)Orange peel powder

Orange peel powder value-added fortified extruded product vermicelli, the utilization of waste orange peel is the most important aspect of this study. Orange belongs to the citrus species *Citrus sinensis* in the family Rutaceae (Figure 2) (Rauf et al., 2014).

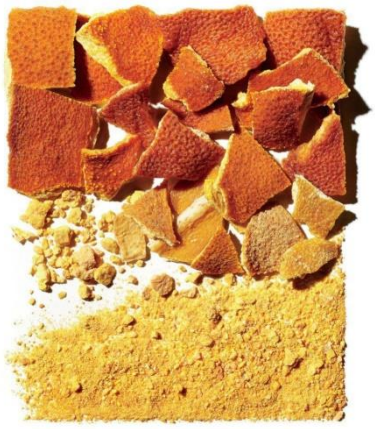

Figure 2:Orange peel powder

Citrus peel, remaining after juice extraction, is the primary waste fraction amounting to almost 50 percent of the fruit mass (Đilas et al., 2009). The orange peel having vital nutrients and certain beneficial properties that affects the gastrointestinal tract's function well (Pal et al., 2012). The waste by-product of orange is used as a valuable functional food and the procedure of making orange peel puree (figure 3) (Block et al., 1992). The peels, in particular, are an abundant source of natural flavonoids and contain a higher amount of phenolics compared to the edible portions (Gorinstein et al., 2001). The contents of total phenolics in peels of lemons, oranges, and grapefruit were 15 percent above those within the peeled fruits (Guimarães et al., 2010). Flavonoids in citrus are a serious class of secondary metabolites. The peel contains the very best amount of flavonoids than other parts and flavonoids present in citrus fruits belong to six peculiar classes according to their structure. They are flavones; flavanones; flavonols; isoflavones; anthocyanidins and flavanols consistent with their structure(Sharma et al., 2019).

Table 2: Nutritional Value of orange peel powder

Nutritional value	Amount	% Daily value
Calories	97	
Total fat	0.2g	0%
Sodium	3mg	0%
Total carbohydrate	25g	9%
Dietary fiber	11g	39%
Protein	1.5g	3%
Calcium	161.00mg	12%
Iron	0.80mg	4%
Potassium	212mg	5%

4)The strategy of fortification to reduce micronutrient deficiency

Fortification of food lowers the micronutrient deficiency (MNDs) from the specific group of the population and improves health (Barker et al., 2018). There are four strategies to reduce MNDs such as dietary improvement, supplementation, food fortification, public health, and other control measures (Tulchinsky., 2010). Short term strategy such as nutrient supplement has been effective in providing immediate relief (Varady et al., 2019). Another strategy is a fortification of staple foods with micronutrients to improve public health in developing countries (Akhtar et al., 2011).

5) Extruder and its effects

Extrusion cooking can be done by hot extrusion and cold extrusion. Hot extrusion refers to the use of high temperature and pressure to form expanded products, it is a high-temperature short time process. Cold extrusion refers to the product is extruded without distortion and cooking of food. It enables the mass production of food and gives uniformity to the final product. It destructs certain naturally occurring toxins (Gaikwad et al., 2018). It reduces the activity of microorganisms from the final product, denaturation of protein, and degradation depends on several parameters such as temperature, light, time, pH, moisture (Nikmaram et al., 2015). Furthermore, there are variable changes during extrusion due to the vast deviation composition and chemical structure of vitamins, thermal degradation is one of the major factors in the loss of β-carotene (Ajita., 2018).

6)Value addition of traditional wheat flour vermicelli

By using whole or refined wheat flour new product is produce named is Vermicelli. The hard dough is prepared, extruded, and dried in the sun (Mogra et al., 2013). Since wheat flour is deficient in lysine, one of the essential amino acids, the protein quality remains poor (Graham et al., 1969). The refining of wheat further reduces nutritional quality. Therefore, the value addition of vermicelli is of prime importance to improve nutrient content and to save its delicacy (Sathya A., 2018).in the growing world and having insufficient time, the value-added products are very useful. There are several types of variations of vermicelli that were prepared using whole wheat flour (WWF); malted wheat flour (MWF); malted wheat flour, green gram, spinach, and sago (MGSS) (Teradal, D., 2013). A spice mix containing powders of tomato, coriander, chilies, turmeric, salt, raw mango powder, black pepper, cloves, and asafetida was also prepared. Recent articles sowed that, the overall satisfactoriness scores for. On 9 point hedonic scales, WWF, MWF, and MGSS were 7.3 ± 6.13, 6.5 ± 0.06, and 8.1 ± 0.01. WWF, MWF, and MGSS contained 6.9 to 7.7% of moisture, 9.3 to 13.5% of protein, 1.2 to 2.7% of fat, 2.9 to 5.8% of ash, 2.2 to 2.4% of crude fiber, 69.8 to 75.2% of carbohydrates, and 344 to 362 kcal/100 g of energy, respectively.MWF vermicelli had the highest amount of total (8.91%), reducing (2.41%) and non-reducing sugars (6.57%). As regards minerals, in MGSS, higher contents of sodium (100 mg), calcium (30 mg), iron (5.9 mg), and zinc (1.4 mg) were found. The shelf life of Vermicelli is 2 months period at room temperature (25–30 °C) (Mogra et al., 2013).

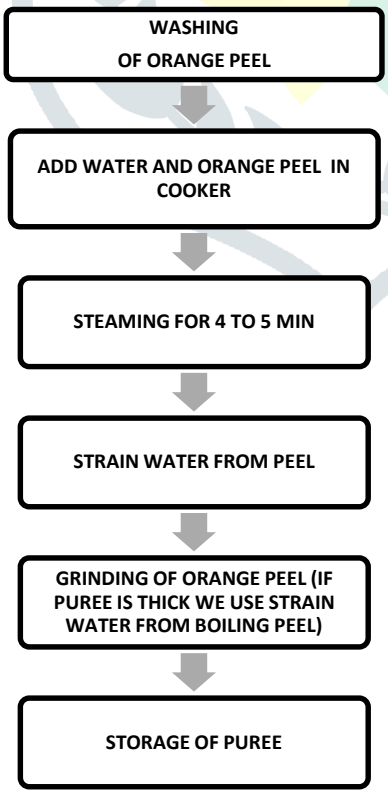

Figure 3: Procedure of preparing orange peel puree

7)Nutrient-rich Vermicelli with Malted Finger Millet Flour (Ragi)

Recently, challenges have been made to develop nutrient-rich vermicelli by the addition of wheat and malted ragi flour in different proportions (90:10 80:20, 70:30, 60:40, and 50:50) for optimization of ratio for production of better quality vermicelli. It was observed that among all the formulations tried, the vermicelli sample prepared with 70:30 (wheat: malted ragi flour) combination had a similar sensory score as that of control. Higher values of protein, fiber, and minerals such as calcium, iron, and phosphorous than the control sample were reported in vermicelli samples incorporated with 30 % of malted ragi flour (Lande et al., 2017). This nutrient-rich vermicelli was a good source of minerals to the consumers (Figure 4) (Kulkarni et al., 2012).

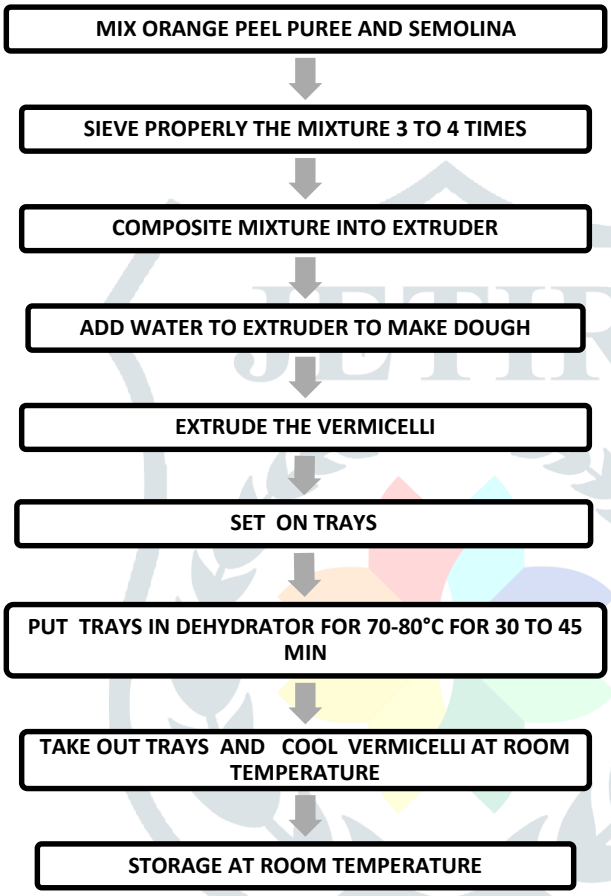

Figure 4: Processing of orange peel vermicelli

8) General health benefits of fortified food

Being a food-based approach food fortified has several health benefits and advantages over other interventions, it can deliver a sufficient amount of micronutrients assigned proportion to the recommended daily allowance (Suchdev et al., 2020). Fortified foods are rich in vitamins, minerals, healthy fats, and fiber that protect against nutrient deficiency and neutralize harmful compounds such as free radicals, prevent cell damage, improve growth factors, and certain chronic diseases such as heart disease, cancer, and diabetes it promotes proper growth and development (Choudhary et al., 2009).

1) **Prevent nutrient deficiency**
   A large group of the population facing nutrient deficiency due to not getting enough amount of essential nutrients from the regular diet. Fortified food helps in controlling or preventing the daily need for nutrients, maintains the body's stores of nutrients. It lowers the risk of multiple deficiencies by seasonal deficits from poor diet. It provides the growth and maintenance factors for growing children, and for those who are going to the age of fertility needs a sustained supply of micronutrients with minimal risk to health (Dary et al., 2006).

2) **Protect against disease**

Fortification of food is done to reduce food hunger and addition of flavor in the regular food. It provides essential vitamins, minerals, and dietary fiber, obesity that prevent the body from several diseases such as heart diseases, cancer, diabetes, and reduces the activity of harmful compound present in the body in the form of free radicals that helps in preventing cell damage. It also boosts health functions and reduces inflammation (Goyal et al., 2014).

3) **Promote growth and development**

Nutrients are essential for the proper growth and maintenance of the body, some nutrients are essential and others are non-essential. Essential nutrients cannot be synthesized by the own body that is consumed by the regular diet. For proper growth and development, several essential nutrients are vitamins, minerals, protein, fat, and carbohydrate that can be consumed by a good diet. For example, cereals fortified with folic acid that is essential for fetal health, omega-3 fatty acids, iron, zinc, and calcium can be fortified into the food to improve the properties of the food (Huma et al., 2007).

1) Infants

Micronutrient deficiencies are more common in infants as their small stomach requires well nutrient-dense food to sustain their growth (Briend A., 2001). Breast milk is best for infants for their initial growth and development, while some of the infants are facing lactose intolerance and not digest the milk, and some mothers cannot breastfeed due to several reasons. Therefore, food fortification is good in such cases and some fortified foods are made for infants such as cerelac (Martin et al., 2016).

2) Adults

As they grow they choose tasty food instead of nutrient-based food, avoids vegetables, and fruits. However, many of the adults not getting enough nutrition such as calcium, magnesium, dietary fiber, and vitamins (A, D, E, and C). For example, soy milk rich in protein and fortified with calcium, whole grains bread rich in folate (vitamin B), skim milk is fortified with vitamin A and vitamin D, whole grain cereals is fortified with vitamin B6, B12 (Miller et al., 2001).

Conclusion

We conclude that the micronutrient deficiency in a large population can be overcome with the help of food fortification. And increase in the use of extrusion products such as pasta, vermicelli, confectionaries. To ensure sustainability in the resource for poor countries, and implemented in concerned with poor people, poverty. It has been made to develop nutrient-rich vermicelli by the addition of semolina and orange peel. nutrient-rich vermicelli was a good source of vitamin C and dietary fiber to the consumers.

References

1. Abeshu, M. A., Lelisa, A., & Geleta, B. (2016). Complementary feeding: a review of recommendations, feeding practices, and adequacy of homemade complementary food preparations in developing countries–lessons from Ethiopia. *Frontiers in nutrition*, *3*, 41.
2. Ajita, T. (2018). Extrusion cooking technology: An advance skill for manufacturing of extrudate food products. *Extrusion of metals, polymers and food products*.
3. Akhtar, S., Anjum, F. M., & Anjum, M. A. (2011). Micronutrient fortification of wheat flour: Recent development and strategies. *Food Research International*, *44*(3), 652-659.
4. Alexander, D. (2000). The geography of Italian pasta. *The Professional Geographer*, *52*(3), 553-566.
5. Anton, A. A., Fulcher, R. G., & Arntfield, S. D. (2009). Physical and nutritional impact of fortification of corn starch-based extruded snacks with common bean (Phaseolus vulgaris L.) flour: Effects of bean addition and extrusion cooking. *Food chemistry*, *113*(4), 989-996.
6. Barker, M., Dombrowski, S. U., Colbourn, T., Fall, C. H., Kriznik, N. M., Lawrence, W. T., ... & Stephenson, J. (2018). Intervention strategies to improve nutrition and health behaviours before conception. *The Lancet*, *391*(10132), 1853-1864.
7. Best, E. T. (1994). Confectionery extrusion. In *The technology of extrusion cooking* (pp. 190-236). Springer, Boston, MA.

8. Block G, Patterson B and Subar A. (1992). "Fruit, vegetables and cancer prevention: a review of the epidemiological evidence". Nutrition Cancer. 18: pp.1-29.
9. Boyaci, B. B., Han, J. Y., Masatcioglu, M. T., Yalcin, E., Celik, S., Ryu, G. H., & Koksel, H. (2012). Effects of cold extrusion process on thiamine and riboflavin contents of fortified corn extrudates. *Food chemistry*, *132*(4), 2165-2170.
10. Briend, A. (2001). Highly nutrient-dense spreads: a new approach to delivering multiple micronutrients to high-risk groups. *British Journal of Nutrition*, *85*(S2), S175-S179.
11. Cheftel, J. C. (1986). Nutritional effects of extrusion-cooking. *Food chemistry*, *20*(4), 263-283.
12. Chemat, F., & Khan, M. K. (2011). Applications of ultrasound in food technology: processing, preservation and extraction. *Ultrasonics sonochemistry*, *18*(4), 813-835.
13. Choo, C. L., & Aziz, N. A. A. (2010). Effects of banana flour and β-glucan on the nutritional and sensory evaluation of noodles. *Food Chemistry*, *119*(1), 34-40.
14. Choudhary, R., & Tandon, R. V. (2009). Consumption of functional food and our health concerns. *Pakistan Journal of Physiology*, *5*(1).
15. Darnton-Hill, I., & Nalubola, R. (2002). Fortification strategies to meet micronutrient needs: sucesses and failures. *Proceedings of the nutrition society*, *61*(2), 231-241.
16. Dary, O., & Hurrell, R. (2006). Guidelines on food fortification with micronutrients. *World Health Organization, Food and Agricultural Organization of the United Nations: Geneva, Switzerland*, 1-376.
17. Đilas, S., Čanadanović-Brunet, J., & Ćetković, G. (2009). By-products of fruits processing as a source of phytochemicals. *Chemical Industry and Chemical Engineering Quarterly/CICEQ*, *15*(4), 191-202.
18. Diner, H. R. (2009). *Hungering for America*. Harvard University Press.
19. Ershow, A. G., Skeaff, S. A., Merkel, J. M., & Pehrsson, P. R. (2018). Development of databases on iodine in foods and dietary supplements. *Nutrients*, *10*(1), 100.
20. Etebu, E., & Nwauzoma, A. B. (2014). A review on sweet orange (Citrus sinensis L Osbeck): health, diseases and management. *American Journal of Research Communication*, *2*(2), 33-70.
21. Fu, B. X. (2008). Asian noodles: History, classification, raw materials, and processing. *Food Research International*, *41*(9), 888-902.
22. GAIKWAD, S., DABIR, S., SINGLA, V., & SWER, T. L. (2018). EXTRUSION TECHNOLOGY FOR FRUITS AND VEGETABLES: PRINCIPLE, METHODS, AND APPLICATIONS. *Technological Interventions in the Processing of Fruits and Vegetables*, 255.
23. Gómez-Galera, S., Rojas, E., Sudhakar, D., Zhu, C., Pelacho, A. M., Capell, T., & Christou, P. (2010). Critical evaluation of strategies for mineral fortification of staple food crops. *Transgenic research*, *19*(2), 165-180.
24. Gorinstein S O, Martín-Belloso, Park Y S and Trakhtenberg. (2001). "Comparision of some biochemical characterstics of different citrus fruits". Food Chemistry. 74: pp.309–315.
25. Goyal, A., Sharma, V., Upadhyay, N., Gill, S., & Sihag, M. (2014). Flax and flaxseed oil: an ancient medicine & modern functional food. *Journal of food science and technology*, *51*(9), 1633-1653.
26. Graham, G. G., PLACKO, R. P., ACEVEDO, G., MORALES, E., & CORDANO, A. (1969). Lysine enrichment of wheat flour: evaluation in infants. *The American journal of clinical nutrition*, *22*(11), 1459-1468.
27. Guimarães, R., Barros, L., Barreira, J. C., Sousa, M. J., Carvalho, A. M., & Ferreira, I. C. (2010). Targeting excessive free radicals with peels and juices of citrus fruits: grapefruit, lemon, lime and orange. *Food and Chemical Toxicology*, *48*(1), 99-106.
28. Hall, C. A., & Day, J. W. (2009). Revisiting the Limits to Growth After Peak Oil: In the 1970s a rising world population and the finite resources available to support it were hot topics. Interest faded—but it's time to take another look. *American scientist*, *97*(3), 230-237.
29. Harper, J. M. (2019). *Extrusion of foods* (Vol. 1). CRC press.
30. Huma, N., Salim-Ur-Rehman, Anjum, F. M., Murtaza, M. A., & Sheikh, M. A. (2007). Food fortification strategy—preventing iron deficiency anemia: a review. *Critical reviews in food science and nutrition*, *47*(3), 259-265.
31. Krishnan, M., & Prabhasankar, P. (2012). Health based pasta: redefining the concept of the next generation convenience food. *Critical reviews in food science and nutrition*, *52*(1), 9-20.
32. Kulkarni, S. S., Desai, A. D., Ranveer, R. C., & Sahoo, A. K. (2012). Development of nutrient rich noodles by supplementation with malted ragi flour. *International Food Research Journal*, *19*(1), 309.

33. Lande, S. B., Thorats, S., & Kulthe, A. A. (2017). Production of nutrient rich vermicelli with malted finger millet (Ragi) flour. *International Journal of Current Microbiology and Applied Sciences*, *6*(4), 702-710.
34. Lorusso, A. V. (2015). OPTIMIZATION OF FUNCTIONAL PASTA BASED ON DURUM WHEAT SEMOLINA.
35. Martin, C. R., Ling, P. R., & Blackburn, G. L. (2016). Review of infant feeding: key features of breast milk and infant formula. *Nutrients*, *8*(5), 279.
36. McPhee, J. (1967). *Oranges*. Macmillan.
37. Milind, P., & Dev, C. (2012). Orange: range of benefits. *Int Res J Pharm*, *3*(7), 59-63.
38. Miller, G. D., Jarvis, J. K., & McBean, L. D. (2001). The importance of meeting calcium needs with foods. *Journal of the American College of Nutrition*, *20*(2), 168S-185S.
39. Mogra, R., & Midha, S. (2013). Value addition of traditional wheat flour vermicelli. *Journal of food science and technology*, *50*(4), 815-820.
40. Nikmaram, N., Kamani, M. H., & Ghalavand, R. (2015). The effects of extrusion cooking on antinutritional factors, chemical propertiesand contaminating microorganisms of food. *International Journal of Farming and Allied Sciences*, *4*(4), 352-354.
41. Pal, D., Banerjee, S., & Ghosh, A. K. (2012). Dietary-induced cancer prevention: An expanding research arena of emerging diet related to healthcare system. *Journal of advanced pharmaceutical technology & research*, *3*(1), 16.
42. Rauf, A., Uddin, G., & Ali, J. (2014). Phytochemical analysis and radical scavenging profile of juices of Citrus sinensis, Citrus anrantifolia, and Citrus limonum. *Organic and medicinal chemistry letters*, *4*(1), 1-3.
43. Riaz, M. N. (2019). Food Extruders. In *Handbook of Farm, Dairy and Food Machinery Engineering* (pp. 483-497). Academic Press.
44. Sathya, A. (2018). Role for Value Addition in Processing Foods of Traditional Varieties of Grains. In *Food Processing for Increased Quality and Consumption* (pp. 423-454). Academic Press.
45. Sharma, K., Mahato, N., & Lee, Y. R. (2019). Extraction, characterization and biological activity of citrus flavonoids. *Reviews in Chemical Engineering*, *35*(2), 265-284.
46. Smoliner, C., Norman, K., Scheufele, R., Hartig, W., Pirlich, M., & Lochs, H. (2008). Effects of food fortification on nutritional and functional status in frail elderly nursing home residents at risk of malnutrition. *Nutrition*, *24*(11-12), 1139-1144.
47. Suchdev, P. S., Jefferds, M. E. D., Ota, E., da Silva Lopes, K., & De-Regil, L. M. (2020). Home fortification of foods with multiple micronutrient powders for health and nutrition in children under two years of age. *Cochrane database of systematic reviews*, (2).
48. Teradal, D. (2013). *Evaluation of grain based wholesome functional foods for geriatric population* (Doctoral dissertation, University of Agricultural Sciences, GKVK).
49. Tulchinsky, T. H. (2010). Micronutrient deficiency conditions: global health issues. *Public health reviews*, *32*(1), 243-255.
50. Varady, K. A., Bhutani, S., Church, E. C., & Klempel, M. C. (2009). Short-term modified alternate-day fasting: a novel dietary strategy for weight loss and cardioprotection in obese adults. *The American journal of clinical nutrition*, *90*(5), 1138-1143.