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Optimization of Underutilized Flaxseed Oil-Cake and its Incorporation into Dietary Millet Cookies

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ABSTRACT: A study was conducted to investigate the potential of flaxseed oil cake flour in enhancing the nutritional value and functional properties of cookies. Cookies were prepared with varying ratios of flaxseed oil cake flour, barley, and little millet flour 0:100, 30:70, 50:50, 70:30, and 100:0 and subjected to sensory, nutritional, and shelf life evaluations. Results indicated that the cookie sample containing a 30:70 ratio of flaxseed flour and millet grain flour demonstrated the most balanced composition of carbohydrate, protein, fat, and crude fiber, and was the most acceptable in sensory evaluations such as Appearance, Aroma, Taste, Texture and Overall Acceptability compared to other samples. Incorporation of flaxseed oil cake flour had the greatest impact on the nutritional characteristics of the cookies, resulting in an overall increase in nutritional content. These findings suggest the potential for utilizing whole flaxseed oil cake flour to improve the nutritional and functional properties of bakery products, such as cookies, and indicate commercial viability for producing high-quality, nutritious cookies.

KEYWORDS: Flaxseed Oil Cake, Barley, Little Millet, Dietary Cookies, Waste Utilization, Optimization.

I. INTRODUCTION

Baking industry is one of the largest organized processed food industries. The popularity of the bakery products is mainly due to their ready-to-eat nature, convenience, low cost and available in a large number of varieties of different tastes and textural profiles. The main advantage of bakery products is their amenability for fortification with cereals, millets or other functional ingredients. Commercially available cookies are particularly deficient in ALA, dietary fiber and lignan[1-2]. Industries are forced to explore different raw materials or to use new technologies/food processes with the aim to develop new functional products. Annually, a major part of agricultural products is converted into by-products and waste material during processing. Most of these ingredients are discarded or consumed as the feed for livestock[3-5]. Many of these by-products are rich in bioactive compounds that can be potentially applied on novel food product development (food additives and functional foods) through waste valorisation under the influence of market trends connected with zero waste and circular economy. Increasing consumer awareness of health issues has created a fast-growing demand for plant-based food products[6-8]. Plant-based products are perceived as healthy foods, containing high levels of antioxidants, vitamins, dietary fibers, and minerals. Among several food crops, in the last two decade, flaxseed has emerged as one of the important and attractive functional food ingredient from several reported scientific literature due to owing the desirable nutrient composition[9-10].

Flaxseed Oil Cake

Flaxseed oil is rich in alpha-linolenic acid (ALA), an omega-3 fat that is believed to be beneficial to humans in various ways. For instance, ALA is said to inhibit inflammatory reactions that cause poor circulation and artery hardening plaque in the human heart (Connor et al. 2018). The oil cake obtained after oil extraction is an 1 overlooked by-product commanding very little premium despite its potentially rich nutrient composition and may be suitable for application in human foods, all things being equal. Most applications of flaxseed in human foods have employed flaxseed meal rather than the oil cake. (Drouillard et al. 2019) reported superior performance of flaxseed oil cake-based diets over full-fat soya meal in terms of sustaining the health of farm animals such as chicken, pigs and cattle[11]. This in part explains why some potential exists for flaxseed oil cake in human food products such as breakfast cereals, energy bars, pancakes and waffles, dry mixes and many baked foods (Morris 2017). Flaxseed oil-cake is rich in omega-3 fatty acids, proteins, soluble and

insoluble fibers, phytoestrogenic lignans, different types of antioxidant compounds, vitamins (A, C, D, and E), and minerals (Mg, K, Na, Fe, Cu, Mn, and Zn) [12]. Many works have reported positive influence of flaxseed consumption with possible applications in medical fields such as colon cancer prevention and reduction of the risk of cardiovascular disease. It is considered a “superfood” and generally recognized as safe (Ganorkar and Jain, 2018) [13]. Flaxseed and flaxseed meals have been researched for their bioactivity and potential health benefits. Flaxseed co-products are gaining attention as promising functional foods and ingredients in the health food market[14]. Refined wheat flour is often used in cookie-making due to its gluten content, but it lacks nutritional value and results in cookies with low protein, fat, and mineral content. To improve the nutritive value of cookies, we replaced refined wheat flour with flour of better nutritive quality.

II. RELATED WORK

Biradar, S. D., Kotecha, P. M., Godase, S. N., & Chavan, U. D. in this theory Studies on nutritional quality of cookies prepared from wheat flour and little millet studied that the present research work was carried out to explore the possibility of utilization of underutilized but highly nutrient rich little millet in cookies. Preliminary experiments were carried out to find out optimum level of little millet flour with wheat flour for the preparation of quality cookies. The quality cookies were prepared from 20% wheat flour and 80% little millet flour (WLF80). The selected treatments were packed in LDPE and PP and stored at ambient ($30 \pm 40^\circ\text{C}$) for 90 days to study their storage feasibility. Chemical composition of the fresh cookies prepared from 20% wheat flour and 80% little millet flour (WLF80) showed that moisture content was 4.26%, protein 8.40%, crude fat 29.10%, crude fiber 6.46%, carbohydrates 67.48% and iron 8.42 mg/ 100 g. The sensory evaluation of cookies was carried out regularly at an interval of one month for 3 month during storage. The results on overall acceptability score of cookies are influenced by storage. The results indicated that score for overall acceptability of cookies decreased for control from 7.40 to 7.20 in LDPE and from 7.30 to 6.80 in PP as storage period get increased[15].

Elik, A., Yanık, D. K., & Göğüş, F had studied Microwave-assisted extraction of carotenoids from carrot juice processing waste using flaxseed oil as a solvent explains that The present study was aimed to evaluate the effect of microwave technology on the extraction yield of carotenoid from carrot juice processing waste using flaxseed oil as solvent. Response surface methodology was employed to optimize the effect of microwave power, extraction time and oil to waste ratio on percentage recovery of carotenoid. Optimum conditions obtained for microwave-assisted carotenoid extraction were 165 W of microwave power, 9.39 min of extraction time and 8.06:1 g/g of oil to waste ratio which gave 5 carotenoid recovery of 77.48%[16].

Deng, X. Q., Pan, Z. F., Li, Q., Deng, G. B., Long, H., Tashi, N., & Yu, M. Q in this paper Nutritional components, in vitro digestibility, and textural properties of cookies made from whole hulless barley explains that barley varieties including waxy and ordinary types were prepared, and its nutritional composition, in vitro digestibility, and textural properties were evaluated. which corresponded to its higher crystallinity and more number of crystalline peaks. Besides, waxy cookies tended to be more crispy, hard, and chewy than ordinary ones. Correlation analyses indicate that amylose and total starch positively influenced starch hydrolysis, but negatively affected cookie texture. Conversely, both protein and β -glucan corresponded with a low estimated GI and high textural parameters[17-18].

Droźłowska, E., Bartkowiak, A., Trocer, P., Kostek, M., Tarnowiecka-Kuca, A., Bienkiewicz, G., & Łopusiewicz, Ł had research on. The influence of flaxseed oil cake extract on oxidative stability of microencapsulated flaxseed oil in spray-dried powders. evaluated that The objective of the study was to investigate the application of flaxseed oil cake extract (FOCE) for oxidative stabilization of flaxseed oil in spray-dried emulsions. Two variants of powders with 10% and 20% of flaxseed oil (FO), FOCE, and wall material (maltodextrin and starch Capsul®) were produced by spray-drying process at 180°C . The oxidative stability of FO was monitored during four weeks of storage at 4°C by peroxide value (PV) and thiobarbituric acid-reactive substances (TBARS) measurements[19].

Droźłowska, E., Bartkowiak, A., Trocer, P., Kostek, M., Tarnowiecka-Kuca, A., & Łopusiewicz, Ł in this theory Formulation and evaluation of spray-dried reconstituted flaxseed oil-in-water emulsions based on flaxseed oil cake extract as emulsifying and stabilizing agent studied that The processing of FOC into Flaxseed Oil Cake Extract (FOCE) (used as a liquid phase) was carried out following the procedure described elsewhere. Starch Capsul® and maltodextrin were used as a wall material in the ratio 1:1 (8.5 g of each per 100 mL of FOCE). The wall components were added to the liquid phase at 25°C and the mixture was stirred (250 rpm) until completely dissolved (approximately 15 min). FO was then added to the solution at a concentration of 10% and 20%, with respect to the total solids content of mixture[20-22].

III.METHODOLOGY

Step1:Weighing of the Ingredient using Weighing Balance
 Step2:Creaming of Unsalted Butter and Sugar
 Step3:Mixing of whisked ingredients (blend flour,bakingpowder,salt)
 Step4:Formation of Dough
 Step5:Refrigerating the Dough for 2 Hours
 Step6:Sheeting and Molding
 Step7:Baking at 165°C for 20 minutes
 Step8:Cooling at room temperature
 Step9:Packed and stored

IV. EXPERIMENTAL RESULTS

This picture describes the final product containing Flaxseed oil cake and Barleywith Little Millet flour at the ratio of 30:70 gave the better acceptable taste, texture,appearance. The developed cookie was rich in omega fatty acids profile, dietary fiber,carbohydrates, minerals, vitamins, proteins.Sensory and nutritional analysis of cookie are tabulated [23-24].

Sensory Evaluation

Cookie were analyzed by five panel members for its sensory characteristics and found that the cookie containing flaxseed flour and millet grain flour at the ratio of 30:70 (Sample 2) gave a better acceptable color, Appearance, Taste, Texture which is tabulated below.

PARAMETERS	MEMBER-1	MEMBER-2	MEMBER-3	MEMBER-4	MEMBER-5
Aroma	9	9	8	8	8
Appearance	8	8	8	9	9
Taste	9	9	9	8	7
Texture	8	9	9	9	9
Overallacceptability	9	9	8	8	8

Sensory Analysis of Cookies

The composition of the cookie containing flaxseed flour and millet grain flour at aratio of 30:70 is considered best because it received the highest scores for acceptablearoma, appearance, taste, and texture among the sensory panel members whoanalyzed it.

Nutritional Analysis of Cookies

PARAMETERS	NUTRITIONAL VALUE
Calories	465 kcal
Protein	8.5g
Fat	25g
Carbohydrates	54g
Crude Fiber	4.5g
Total Sugar	16g
Sodium	133 mg
Moisture	8%
Ash	0.5%

Nutritional Analysis of Cookie

The nutritional analysis of Flaxseed Cookies shows that they are a good source of energy, with 465 calories per 100g. They also contain 8.5g of protein, which is important for building and repairing muscle tissue, and 25g of total fat, which provides the body with essential fatty acids. Flaxseed Cookies are also a good source of carbohydrates, with 54g per 100g, providing the body with energy to fuel its activities. They are high in crude fiber, with 4.5g per 100g, which is important for maintaining digestive health and reducing the risk of chronic diseases such as heart disease and diabetes. Additionally,

the Flaxseed Cookies have a low sugar content of 16g per 100g, which can help to reduce the risk of dental cavities and metabolic disorders when consumed in moderation. They are also low in sodium, with 133 mg per 100g, which can help to reduce the risk of high blood pressure in some individuals.

V. CONCLUSION

Cookie sample containing 30:70 ratio of flaxseed flour and millet grain flour represent balanced quantities of carbohydrate, protein, fat, crude fiber and sample were most acceptable in sensory evaluation as compared to other samples. The results have shown the possibility of utilizing whole flaxseed oil cake flour to improve the nutritional and functional properties of cookies. The greatest impact on the nutritional characteristics was observed in the incorporation of flaxseed oil cake flour which increases the overall nutritional content of the cookies. Therefore the developed cookies indicated the commercial scope of manufacturing good quality

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