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Sensory and Functional Properties of *Linum usitatissimum* (Flaxseed) Incorporated Pulse based Ready to Cook (RTC) Health Mix for Women of Reproductive Age

Megha M. Katte, D. Vijayalakshmi

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ABSTRACT

Background: Scientific evidence supports therapeutic properties of flaxseed; however, a large sector of the population is still unaware of the associated benefits and its possible applications as usage in food prodcuts. Flaxseed is popularly known for its high alpha-linolenic acid content, but is also a source of lignan, fibre and protein that are biologically active in the prevention of some non-transmissible chronic diseases.

Methods: Methodology involved in the study has focused on formulation of health mix by standardising the amount of flaxseed incorporated, sensory evaluation of the formulated product by semi-trained panel members, assessment of functional properties, and analysis of macronutrient composition.

Result: The developed health mix is a good source of protein (15 g per 100 g) and fiber (13 g per 100 g). Water soluble index of 5.23 per cent, swelling power 12.50 per cent and solubility index of 17.62 per cent was observed in the developed flour. Health mix containing 10 g of flaxseed per serving had best acceptance.

Key words: Flaxseed, Functional properties, Health benefits, Reproductive age, Sensory attributes.

INTRODUCTION

Consumer's interest with respect to healthy eating has shifted towards the potential health benefits of specific foods and food ingredients in the last decades. Foods, in fact, are not intended to only satisfy hunger and to provide basic nutritional requirements but also to prevent nutrition-related diseases and to improve physical and mental wellbeing of the consumers. This consumer demand has led to the development of new food products with greater beneficial effects.

Flaxseed is emerging as an important functional food ingredient. Flaxseed is the seed of flax plant, an annual herb, and is a member of the Linaceae family. The specie is native to the region extending from the eastern Mediterranean, through Western Asia and the Middle East, to India.

Linseed contains oil rich in omega-3, digestible proteins and lignans. In addition, flaxseed is an essential source of soluble fiber and has considerable potential as a source of phenolic compounds (Oomaah 2001; Pengilly, 2003). For human consumption, flaxseed can be incorporated into traditional cereal-based products and in ready-to-eat foods known for their high consumer acceptability Mercier *et al*. (2014).

Flax seed sprouts are edible, with a slightly spicy flavour. Its consumption is linked to several potential health benefits. Supplementation of flaxseed on hormonal levels in women of reproductive age has improved health parameters like weight, insulin, total serum testosterone, free serum testosterone along with clinically-significant decrease in androgen levels with a concomitant reduction in hirsutism (clinical symptom of PCOS) Nowak et al. (2007). Long-term effect of a pulse-based diet and exercise training intervention on body composition and dietary intake in women of reproductive age has revealed positive effects McBreairity *et al.* (2015).

Department of Food Science and Nutrition, Gandhi Krishi Vigyana Kendra, University of Agricultural Sciences, Bengaluru-560 065, Karnataka, India.

Corresponding Author: Megha M. Katte, Department of Food Science and Nutrition, Gandhi Krishi Vigyana Kendra, University of Agricultural Sciences, Bengaluru-560 065, Karnataka, India. Email: meghakatte91@gmail.com

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Pulse-based diet reduces body fat and improves blood lipids in women with ovarian cysts (Zello *et al.* 2013). Flaxseed powder also has effects on improving ovarian morphology, menstrual cycle, hirsutism and blood sugar in PCOS (Farzana *et al,* 2015) suggesting flax seed can be further explored as an alternative source of treatment for PCOS. With this background, the current study focuses on developing a ready-to-cook pulse-based health mix incorporated with flaxseed powder.

MATERIALS AND METHODS

Formulation of flaxseed incorporated health mix

Ingredients like wheat, green gram, bengal gram, flax seed, carrot, knol khol, chilli, curry leaves, dill leaves and flax seed were purchased from local market. All ingredients were cleaned, tray dried and kept in air tight 350 guage HDPE

food grade packs, in a cool and dry place prior to use. These ingredients were used in definite proportion to develop health mix.

Health mix was prepared with pulse flour as the base. Pulse diet helps in treating the PCOS among women of reproductive age. Along with this flaxseed was incorporated at different variations. The flaxseed was limited to 15 g as the recommended maximum dosage is 15 g (Farzana *et al.* 2015). Dehydrated dill leaves, coriander, knol khol, carrots were also added along with a cereal flour to improve its nutritional value. Thoroughly washed greens, washed and chopped vegetables were tray dried at 50°C for 8 hours individually brought to room temperature and powdered. The developed products from health mix were subjected to sensory evaluation along with a control sample to test for their consumer acceptance by trained panel members.

Sensory evaluation of the developed product

All the developed product was evaluated by a panel of semi trained judges (n=26). The products were evaluated for appearance, texture, aroma, taste and overall acceptability on a nine-point hedonic scale Cardello *et al.* (1985).

Where, 9=like extremely, 8=like very much, 7=like moderately, 6=like slightly, 5=neither like or dislike, 4=dislike slightly, 3=dislike moderately, 2=dislike very much, 1=dislike extremely.

Functional properties of health mix

Swelling power and solubility tests were carried out in the temperature ranges of 55 - 95°C, using the method of Leach *et al.* (1959). Water and oil absorption capacity tests were performed following the methodology given by Del Rosario and Flores, (1981). Bulk density test was formed using the methodology given by Wang and Kinsella, 1976.

$$\text{Bulk density (g/ml)} = \frac{\text{Weight of sample (g)}}{\text{Volume of sample (ml)}}$$

Nutrient composition of health mix

The developed health mix was used for the analysis of macro nutrients such as moisture, protein, fat, crude fiber, and ash by standard methods AOAC (1980). Carbohydrate and energy contents were computed. The samples were analysed in triplicates and average values were recorded.

The research work was carried out in Dept. of Food Science and Nutrition, UAS, GKVK, Bengaluru during the year 2018.

RESULTS AND DISCUSSION

Formulation of health mix

Green gram and bengal gram were chosen for health mix as they are relatively less used in comparison to red gram and black gram in Indian diet. Wheat flour was used to improve the binding property of the health mix, so as to develop different products out of it (Fig1).

Flaxseed has shown its benefits in treating PCOS when supplemented at a dose of 15 g/day, due to its lignan and omega -3 content (Farzana *et al.* 2015). It is a underutilized oil seed in India (except few regions in northern Karnataka for traditional preparations; preferably chutney powder). Hence, flaxseed was incorporated in different proportions (5 g, 10 g and 15 g per serving) to health mix and was subjected to sensory evaluation to find the best accepted level of incorporation.

To improve the functional properties of the health mix, vegetables and GLVs were used. This improves the nutritive value of health mix than a blend of cereal, pulses and oil seed alone. Cereal, pulses, vegetables, GLVs and oil seed were used in different proportions to formulate the health mix. Dehydrated vegetables and GLVs were used in order to make the health mix nutridense and to improve its shelf life. The pulses and oil seed were dry roasted before milling. The formulated health mix contained cereal and pulses and in the

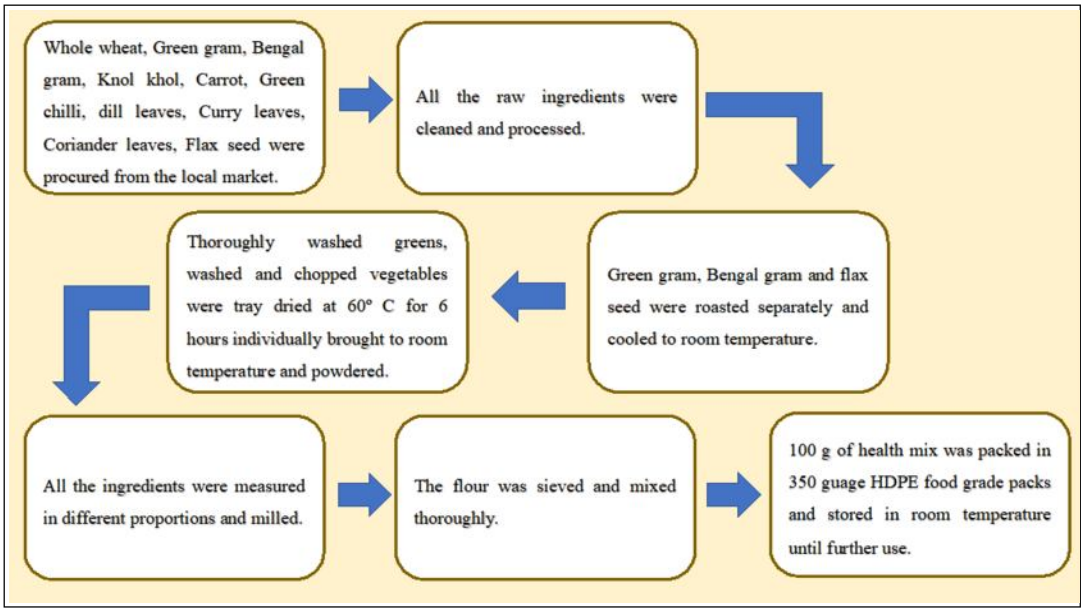

Fig 1: Flow chart for preparation of helath mix.

ratio of 4:4 and the flaxseed was incorporated in 5 g, 10 g and 15 g to health mix and was further tested for sensory properties to know the consumer acceptance.

Functional properties are those parameters that determine the application and use of food materials for various food products. The mean value of water absorption capacity was found to be 6.54 g/ml (Table 1). The water absorption capacity of the 100 per cent health mix was higher than the wheat flour. This could be indicative of the fact that, addition of green gram flour, bengal gram flour and other ingredients confer high water binding capacity, which in turn improves the reconstitution ability and textural properties of dough Ajanaku *et al.* (2012).

The water absorption capacity (WAC) is important in the development of ready to eat foods and a high absorption capacity may assure product cohesiveness Housson and Ayenor (2002). The water absorption capacities of the flours are useful indications of whether protein can be incorporated with the aqueous food formulations, especially, those involving dough handling. An interaction of protein with water is important to properties such as hydration, swelling power solubility and gelation Etudaiye *et al.* (2009). Similarly, Ali *et al.* (2012) mentioned that, the water absorption capacity (WAC) of pearl millet was improved to 143 ml H_2O/100 g, 163 ml H_2O/100 g and 180 ml H_2O/100 g with increase in the level of soybean supplementation to 5,10 and 15 per cent, respectively.

Oil absorption capacity of the health mix was 2.86 g/ml (Table 1). Similar findings are reported by Kinsella, (1979). Researcher opined that, Oil Absorption Capacity (OAC) is the ability of flour protein to physically bind fat by capillary attraction and it is of great importance, since fat acts as flavour retainer and also increases the mouth feel of foods, especially bread and other baked foods. The oil absorption capacity of pearl millet improved significantly (P≤0.05) with increase in the level of soybean supplementation to 130 ml oil/100 g flour, 138 ml oil/100 g flour and 150 ml oil/100 g for the levels, respectively Ali *et al.* (2012). Observed OAC of the health mix found to be relatively higher could be due to the high protein composition of the flour studied.

Water soluble index of 5.23 per cent, swelling power 12.50 per cent and solubility index of 17.62 per cent was observed in the developed flour (Table 1). The swelling power and solubility index value are on par with the values reported by Adebowale *et al.* (2008). Moorthy and Ramanujam (1986) reported that the swelling power of flour granules is an indication of the extent of associative forces within the granules.

Swelling power is also related to the water absorption index of the starch-based flour during heating. Swelling capacities is regarded as quality criterion in some good formulations such as bakery products. It is an evidence of non-covalent bonding between molecules within starch granules and also a factor of the ratio of á-amylose and amylopectin ratios Osungbaro *et al.* (2010) and Rasper (1969).

Bulk density of the health mix was 0.93 g/ml (Table 1). This value is slightly higher than the value reported by Adebowale *et al.* (2012). The bulk density is generally affected by the particle size and the density of flours or flour blends and it is very important in determining the packaging requirement Adebowale *et al.* (2008) and Ajanaku *et al.* (2012). The differences in the value of bulk density are likely due to different ingredients used.

Using health mix, traditionally well-known product *roti* was prepared as control. Three variation of health mix was given for sensory evaluation. Variation 1 contained 5 g, variation 2 contained 10 g and variation 3 had 15 g of flaxseed powder respectively (Fig 2). All the three variations were used to prepare *roti* to know the consumer acceptance of flaxseed powder in pulse-based health mix.

Sensory evaluation of the developed product indicates that health mix containing 10 g flaxseed per serving was best accepted in all the three variations and was statistically significant at 1 per cent level with respect to sensory attributes (Table 2 and Fig 3). Similarly, Banu *et al.* (2012) studied the sensory properties of multi-whole grain mix formulated by

Table 1: Functional properties of the health mix.

Functional properties	Mean*
Water absorption capacity (g/ml)	6.54
Oil absorption capacity (g/ml)	2.86
Water soluble index (%)	5.23
Swelling power (%)	12.50
Solubility (%)	17.62
Bulk density (g/ml)	0.93

*- Mean values are mean of triplicates.

Table 2: Mean sensory scores of roti.

Variations	Appearance	Texture	Colour	Aroma	Taste	Overall acceptability
Control	8.5	8.3	8.2	8.7	8.5	8.7
HM + 5 g of flax seed	8.1	7.9	8.0	8.2	8.1	8.2
HM + 10 g of flax seed	8.3	8.0	8.1	8.3	8.3	8.4
HM + 15 g of flax seed	8.0	7.8	7.9	8.3	8.1	7.9
F – value	6.81**	3.75^{NS}	8.91**	2.60^{NS}	15.48**	10.65**
SEm±	0.07	0.04	0.05	0.05	0.04	0.05
Critical difference(CD)	0.26	0.17	0.22	0.19	0.15	0.18

HM- Health mix, **- Significant at 1% level, NS- non-significant.

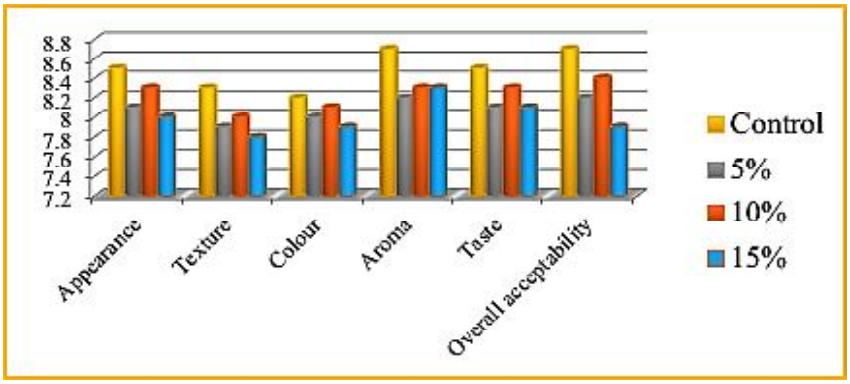

Fig 2: Mean sensory scores of roti.

Health mix **Control *roti*** **Best accepted *roti* (10 %)**

Fig 3: Health mix and its products.

Table 3: Macro nutrient composition of the health mix per 100 g.

Nutrient	Content	% contribution	
		360 (Kcal)	1200 (Kcal)
Moisture (%)	5.30	-	-
Protein (%)	15.58	17.31	5.19
Ash (%)	2.12	-	-
Fat (%)	8.28	20.70	6.21
Crude fiber (%)	13.02	-	-
Carbohydrate (%)	55.70	61.89	18.57
Energy (Kcal)	359.64	Total	29.97

using cereals, millets, pulses and nuts. They found that, the overall acceptability was 7.7. This indicates that the product can be used for preparing different products and can be consumed by young and adult to avail the health benefits of flaxseed.

The macro nutrient composition of the health mix shows that, the flour contains 15 per cent of protein, 13 per cent of crude fiber and 8 per cent of fat. The developed health mix is a good source of protein, as when consumed for a meal provides nearly 18 per cent of the calories from protein (Table 3). Developed mix contained good amount of protein (15.58%), fat (8.28%) and crude fiber 13.02 per cent (Table 3). Health mix contained 55.70 g of carbohydrate and provided 359.64 Kcal of energy. The protein content of health mix was higher than any other cereals and legumes excluding soy. The developed health mix contained higher amount of protein, fat and fiber compared to millet incorporated composite flour developed by Vijaykumar *et al.* (2010).

Higher protein composition in the health mix is desired due to the fact that, it decreases lean body mass in PCOS subjects over a period of time. The high amount of fat in health mix is due to the incorporation of flax seed. High protein levels can compensate for low or borderline levels of other dietary ingredients; for example, with low-calorie diets increased amounts of protein serve as a substitute for energy source Albanese. (1963).

Diets containing high amount of protein are highly prescribed for health conditions like PCOS. In general, for PCOS, 60, 20 and 20 per cent of their calories are prescribed from carbohydrates, proteins and fats respectively (Macrae *et al.* 1993). Currently prescribed PCOS diets contain moderate carbohydrate, high fibre and low fat. Similarly, Developed health mix also provide nearly 62, 18 and 20 per cent of calories from carbohydrate, protein and fat respectively.

Even though the flour is rich in fat, it contains omega-3 fatty acids from flaxseed which helps in weight reduction. One can consume 60 g of the flour in preferred form per meal and this provides 360 Kcal. When a person is aiming for weight loss and wants to consume 1200 Kcal diet per day, replacing a meal with health mix (60 g) products meets 1/3rd of the daily requirement (30% of 1200 Kcal).

CONCLUSION

Although flaxseed has been well known since ancient times, at present it is not massively used in the formulation of food products; however its popularity has increased due to recent studies. Flaxseed contains important quantities of functional properties, such as lignans, soluble fibre and protein, making flaxseed incorporated health mix an attractive source of functional ingredients for the preparation of food products for women of reproductive age group. The developed health mix for women of reproductive age combining cereal, pulses, and dehydrated vegetables and GLVs along with an oilseed has a good source of protein and fiber and has good acceptability. However, the effects of flaxseed health mix in prevention of certain non-transmissible chronic diseases needs to further study.

Conflict of interest: None.

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