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RESEARCH ARTICLE

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Nutritional Efficacy of Maize based Functional Flour Developed for Minimizing the Risk of Lifestyle Diseases in Relation to Normal Wheat Flour

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ABSTRACT

Background: Lifestyle diseases are ailments caused due to unhealthy living pattern. Maize being an affordable and inexpensive cereal crop for unprivileged people and has potential benefits also which can be utilized with other grains to develop functional flour.

Methods: The present investigation was conducted during 2020-21 in the Laboratory of Department of Food and Nutrition, Dr. RPCAU. The raw ingredients *viz.* maize (variety 'Lakshmi'), flaxseed, chickpea, barley, ragi and wheat were procured from local market Pusa or farmers. After processing with various methods, different proportions of flour were developed. Bulk density, water absorption capacity and proximate composition were determined.

Result: The result showed that bulk density ranged from 0.57 to 0.67 g/ml, whereas water absorption capacity varied from 1.08 to 2.16 g/ml. Proximate composition such as moisture content ranged from 6.53 to 11.55 g/100 g, ash 1.26 to 1.9 g/100 g, protein 5.83 to 11.08 g/100 g, fat 1.60 to 5.33 g/100 g, fibre 11.09 to 18.27 g/100 g, carbohydrate 56.45 to 65.09 g/100 g whereas level of minerals like iron varied from 3.68 to 5.71 mg/100 g, zinc 2.83 to 3.76 mg/100 g and calcium 25.73 to 132.28 mg/100 g.

Key words: Functional flour, Lifestyle diseases, Maize, Processing.

INTRODUCTION

Goodness of health status understands the perfect peace of mind, body and soul. Lifestyle diseases are the ailments that are primarily centered on regular habits of people which detract them from physical activity and ultimately push towards a sedentary routine pattern that can cause numerous health related problems. According to World Health Organization (WHO) the most prevalent lifestyle diseases are diabetes, cardiovascular diseases, obesity, colon cancer, depression *etc*. However, the glycemic index of normal wheat flour is higher, although it contains protein gluten which acts as a binding agent and improves the quality or texture of food products.

Cereals are playing a key role in our daily life by providing energy and other macro or micro nutrients which defeats our body from various causative factors. Globally, maize is known as "queen of cereals". After rice and wheat maize is the third most important food crop (ICAR-IIMR, 2017). However, maize is the most multi-skilled emergent crop which is widely accepted under various agro-climatic environments and required lesser water content for its cultivation as compared to other cereals. The cultivation of maize takes place in every season (*kharif, rabi*, zaid) in Bihar hence availability is not the problem. The total area, production and productivity under maize crop in Bihar is about 669478 ha, 3193911 million tones, 4771 kg/ha respectively (Directorate of Economics and Statistics, 2018-19).

Functional flours are the amalgamation of several kind of flours prepared from cereals, pulses, oilseeds *etc*. which serves numerous nutritional and therapeutic properties and protects the body from hazards. As reported by FAO application of composite mixes in food products will be advantageous economically (Noorfarahzilah *et al*. 2014). Flaxseed or "Linseed" *(Linum usitatissimmum)* is an oilseed crop which is richer in specific nutrients and plays a beneficial role for cardiovascular patients such as omega-3 fat, ALA (α- linolenic acid) and lignan which possess plant estrogen along with antioxidant qualities (Gutte *et al*. 2015). Chickpea *(Cicer arietinum)* is a legume mostly consumed by people in various form of products. It had beneficial effects if consumed in combination with cereals against diseases mainly cardiovascular diseases, cancers, type-2 diabetes and various digestive disorders (Jukanti *et al*. 2012). Barley *(Hordeum vulgare)* is one of the oldest and cheapest grains having various health benefits against type 2 diabetes, obesity, colon cancer, atherosclerosis, coeliac disease etc. due to presence of flavonoids, selenium, total fibre both, proteins, copper, vitamin B, E, magnesium (Annapurna *et al*. 2011). Finger millet *(Eleusine coracana)* or "Ragi' is rich

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in mainly calcium which needs for older people because it enhances bone mineral density. Phytochemicals elements present in finger millet are alkaloids, cardiac glycosides, phenols, tannins, terpenoids and steroids (David *et al*. 2014). Wheat *(Triticum aestivum)* is a staple crop. It contains protein gluten which provides better texture and rolling capacity of product prepared from it.

Considering the necessity and availability of grains the present investigation has been designed to develop functional flour of maize in combination with other food materials so that it can be utilized by people who have been suffering from lifestyle diseases or are at the verge of these diseases.

MATERIALS AND METHODS

The specific research work on "Nutritional efficacy of maize based functional flour developed for minimizing the risk of lifestyle diseases in relation to normal wheat flour" was conducted during 2020-2021 in the laboratory of Department of Food and Nutrition, College of Community Science, Dr. RPCAU, Pusa, Bihar. The raw ingredients for the development of functional flour such as maize (variety 'Lakshmi'), chickpea, wheat, barley, flaxseed and finger millet were procured from local market or directly from farmers.

Processing of raw materials

The raw grains were processed by different methods viz. soaking, boiling, roasting and oven drying. Firstly, all grains were cleaned to remove inedible parts; washed under tap water for 2 to 3 times. However, maize was steeped in double amount of water for 10 to15 minutes, boiled and then oven dried for 10 hours at 60-65°C. Flaxseed were roasted, cooled at room temperature and grounded. Chickpea, ragi, barley and wheat were soaked in water (1:2 w/v) for overnight (8-10 hours). Next day water was drained and grains were oven dried at 60-65°C. Chick pea required 12 hours for drying whereas finger millet, barley and wheat used to take 7 hours at 60-65°C for drying. Oven dried grains were milled and stored in air tight containers.

Development of functional flour in different proportions

After processing of grains, functional flour was prepared at varied combinations by using different flour of grains. Combination of both cereals and millets provide more nutrients, phytochemicals and antioxidants which helps to maintain better health status (Agarwal *et al*. 2016). For the development of flour, wheat flour (100%) was taken as control, the portions of maize (50%) and flaxseed (10%) had been fixed since, maize is the base material for the development of flour and flaxseed have been decided to be added compulsorily because of its nutritional properties (omega-3 fat). Variations were there in rest 40 per cent for the development of flour. The flour was mixed properly in each combination and kept in airtight container to prevent from spoilage. Different combinations of flour are shown in Fig 1.

Physico-chemical analysis

The physico-chemical properties of functional flour have been ascertained by determining bulk density and water absorption capacity.

Bulk density

As per protocol stated by Wang and Kinsella (1976) bulk density was determined. Fifty gram flour sample was taken into 100 ml of measuring cylinder. The bottom of cylinder was mechanically tapped 15 to 20 times to remove the air spaces between the sample. The volume was noted at which flour sample was settled (tapped volume) thereafter, bulk density was evaluated as mass per unit volume of the flour sample.

$$\text{Bulk density (g/ml)} = \frac{m}{v}$$

Water absorption capacity

It was determined by the procedures followed by Rosario and Flores (1981). One gram of sample was mixed with 10 ml of distilled water. The content was allowed to stand at 30°C in a water bath for 30 minutes and was further centrifuged at 3000-5000 rpm for 20 to 30 minutes. After centrifuging, the volume of the supernatant was recorded and used for determination of water absorption and the results were expressed as g/ml.

Proximate composition

Different flour combinations were analyzed for nutritional characteristics such as moisture, ash, crude fibre and fat by the method prescribed by AOAC (2000). Crude protein content was estimated by Micro-Kjeldahl method (NIN, 1983). The micronutrient content (Fe and Zn) was determined by using Atomic Absorption Spectrophotometer (Lindsay and Norvell, 1978) whereas whereas calcium was analysed by complexo-metric titration method (Chang and Bray, 1951).

Statistical analysis

All the analyses were carried out in three replication (triplicate) of samples and results were shown on dry weight

Table 1: Combination of grains for the development of functional flour.

Code	Maize (g)	Flaxseed (g)	Chickpea (g)	Barley (g)	Ragi (g)	Wheat (g)
T_0	-	-	-	-	-	100
T_1	50	10	20	20	-	-
T_2	50	10	20	-	10	10
T_3	50	10	20	-	20	-
T_4	50	10	20	10	-	10
T_5	50	10	10	10	10	10

basis. The data obtained from bulk density and water absorption capacity were analyzed by student t-test ($p<0.05$) and presented at the level of $p<0.01$ for significance. OPSTAT software and completely randomized design (CRD); one way ANOVA (Analysis of Variance) was used for data obtained from different treatments of flour to assess the significance.

RESULTS AND DISCUSSION

Bulk density of flour

The bulk density of different treatments of flour has been presented in Table 2. The highest bulk density was seen in treatment T_5 and T_3 (0.67 g/ml each) followed by T_1 (0.65 g/ml), T_4 (0.62 g/ml) and T_2 flour (0.60 g/ml). As compared with other treatments, wheat flour (0.57 g/ml) had lower bulk density. Significant difference was found between T_1, T_5 treatment ($p<0.05$) and T_2 treatment ($p<0.01$) as compared to control.

Water absorption capacity (WAC) of flour

The water absorption capacity of flour has been presented in Table 3. The amount of water absorbed by treatment T_5 flour was 2.16 g/ml subsequently higher than T_4 flour (2.13 g/ml), T_2 flour (1.86 g/ml), T_3 flour (1.86 g/ml), T_1 flour (1.80 g/ml) and control (1.03 g/ml) which absorbed less amount of water. The WAC of different treatments of flour was higher compared to wheat flour because of higher carbohydrate content in millet flour (maize and ragi) including barley flour. Statistically significant ($p<0.01$) difference was observed in T_3, T_4, T_5 and T_2 flour ($p<0.05$) compared to control.

Proximate composition of functional flour

The proximate composition of functional flour prepared from different proportions of grains was shown in Table 4. Meanwhile, the moisture content of T_0 was 11.55 g/100 g and observed higher than T_2 flour (7.97 g/100g) followed by T_1 flour (7.60 g/100g) T_3 flour (6.96 g/100g), T_5 flour (6.79 g/100g 1) and T_4 flour (6.53 g/100g) which holds least moisture content. Statistically, all treatments are significant ($p<0.05$) when compared with control. The highest ash content among five treatments of flour was found in T_5 flour *i.e.* 1.94 g/100g, subsequently T_2 flour (1.89 g/100 g), T_4 flour (1.85 g/100g), T_1 flour (1.84 g/100 g) and T_3 flour (1.82 g/100g) and T_0 (1.26 g/100 g) which was lowest among all treatments. Statistically non-significant difference was found among each other as compared to control.

In case of protein content, T_2 flour *i.e.* 11.08 g/100 g found to be highest as compared to others followed by T_0 (10.97 g/100 g), T_1 flour (8.78 g/100 g), T_3 flour (8.75 g/100 g), T_4 flour (7.58 g/100 g) and lower protein content encompassed in T_5 flour (5.83 g/100 g) respectively. The data depicted, statistically all treatments are significant ($p<0.05$) compared with control except T_2 flour. Comparatively, T_2 flour contains highest fat content *i.e.* 5.33 g/100 g than T_3 flour (5.30 g/100 g) followed by T_4 flour (5.28 g/100g), T_1 flour (5.27 g/100 g), T_5 flour (4.92 g/100 g) and T_0 (1.60 g/100 g) which was lowest in fat

Table 2: Bulk density of functional flour.

Treatment	Bulk density (g/ml)	't value'	
T_0	0.57±0.03		
T_1	0.65±0.01	T_0*T_1	6.10*
T_2	0.60±0.01	T_0*T_2	1.96 ^{NS}
T_3	0.67±0.01	T_0*T_3	26**
T_4	0.62±0.02	T_0*T_4	2.5 ^{NS}
T_5	0.67±0.02	T_0*T_5	6.39*

All the observations are mean±SD. NS-Non significant
*(p<0.05) **(p<0.01)

Table 3: Water absorption capacity of functional flour.

Treatment	Water absorbed (g/ml)	't value'	
T_0	1.03±0.05		
T_1	1.80±0.43	T_0*T_1	1.98 ^{NS}
T_2	1.86±0.25	T_0*T_2	4.72*
T_3	1.86±0.05	T_0*T_3	25**
T_4	2.13±0.15	T_0*T_4	11**
T_5	2.16±0.15	T_0*T_5	12.85**

All the observations are mean±SD NS- Non significant
*(p<0.05). **(p<0.01)

Table 4: Proximate composition of functional flour (g/100 g) on dry weight basis.

Treatment	Parameters (g/100 g)					
	Moisture	Ash	Protein	Fat	Fibre	Carbohydrate
T_0	11.55±0.05	1.26±0.07	10.97±0.31	1.60±0.37	11.09±0.21	65.09±0.36
T_1	7.60±0.58	1.84±0.02	8.78±0.06	5.27±0.01	18.27±0.15	58.22±0.79
T_2	7.97±2.71	1.89±0.03	11.08±1.01	5.33±0.01	17.26±0.02	56.45±2.30
T_3	6.96±0.85	1.82±0.02	8.75±0.00	5.30±0.01	17.36±0.02	59.97±0.96
T_4	6.53±0.23	1.85±0.02	7.58±2.02	5.28±0.02	17.64±0.07	61.10±2.19
T_5	6.79±0.61	1.94±0.02	5.83±1.01	4.92±0.02	16.37±0.03	64.15±1.60
C.D.	0.916	0.069	1.833	0.280	0.205	2.821
SE(m)	0.294	0.022	0.588	0.090	0.066	0.905
SE(d)	0.416	0.031	0.832	0.127	0.093	1.281
C.V.	7.182	2.167	1.532	3.365	0.697	2.592

Values are expressed as mean±SD C.D. at 5%.

Fig 1: Different treatments of functional flour to normal wheat flour.

content. Statistically, all treatments showed significant difference ($p<0.05$) among themselves when compared with control.

In the case of fibre, it was found highest in T_1 flour *i.e.* 18.27 g/100 g followed by T_4 flour (17.64 g/100 g), T_3 flour (17.36 g/100 g), T_2 flour (17.26 g/100 g), T_5 flour (16.37 g/100 g) and T_0 (11.09 g/100g) which had lower amount of fibre content. There was significant ($p<0.05$)difference among each treatment when compared with T_0 (Control). Carbohydrate content was seen highest in T_0 *i.e.* 65.09 g/100 g followed by T_5 flour (64.15 g/100 g), T_4 flour (61.10 g/100 g), T_3 flour (59.97 g/100 g), T_1 flour (58.22 g/100 g) and T_2 flour (56.45 g/100 g) which holds lower carbohydrate content as compared to others. Significant ($p<0.05$) difference was found in all treatments of flour except T_5 flour.

Mineral content of the flour

The iron, zinc and calcium content of different flour blends have been presented in Table 5. The iron (Fe) content was highest in T_1 flour (5.96 mg/100 g) followed by T_5 flour (5.71 mg/100 g), T_4 flour (5.57 mg/100 g), T_3 flour (5.31 mg/100 g), T_2 flour (4.34 mg/100 g) and T_0 (3.68 mg/100 g). The

Table 5: Mineral content of different treatments of functional flour.

Treatment	Parameters (mg/100 g)		
	Iron	Zinc	Calcium
T_0	3.68±0.43	2.83±0.27	25.73±0.64
T_1	5.96±0.37	3.67±0.22	63.57±0.03
T_2	4.34±0.74	3.76±0.23	98.39±0.12
T_3	5.31±0.72	2.93±0.18	132.28±0.16
T_4	5.57±1.00	3.66±0.37	64.11±0.17
T_5	5.71±0.51	3.10±0.43	85.91±0.17
C.D.	1.203	0.588	0.529
SE(m)	0.386	0.189	0.170
SE(d)	0.546	0.267	0.240
C.V.	3.118	9.834	0.380

All values are (Mean±SD) of three observations C.D. at 5%.

statistically analyzed data manifested that except T_2 flour all treatments were found to be significant ($p<0.05$). In case of zinc (Zn) content, it had been observed highest in T_2 flour viz. 3.76 mg/100 g followed by T_1 flour (3.67 mg/100g), T_4 flour (3.66 mg/100 g), T_5 flour (3.10 mg/100 g) , T_3 flour (2.93 mg/100 g) and lowest zinc content was found in T_0 (2.83 mg/100 g). The T_3 and T_5 flour are significantly ($p<0.05$) different as compared with control.

Calcium content was found highest in T_3 flour (132.28 mg/100 g) followed by T_2 flour (98.39 mg/100 g), T_5 flour (85.91 mg/100 g), T_4 flour (64.11 mg/100 g), T flour (63.57 mg/100 g) and the lowest amount of calcium was found in T_0 flour (25.73 mg/100g) respectively. When compared with control each treatment was significantly different ($p<0.05$).

CONCLUSION

Based on the findings, it can be concluded that functional flour developed from using maize as a base material in combination with other raw ingredients were rich in nutritional characteristics. However T_1, T_2 and T_3 treatments were found best because they are rich in fibre, iron, zinc (T_1), protein, omega-3 fats (T_2) and calcium (T_3). Due to natural sources of nutrients and antioxidants, it may be utilized to overcome causative factors of lifestyle diseases.

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Conflict of Interest: None.

REFERENCES

Agrawal, A., Verma, A. and Shiekh, S. (2016). Evaluation of sensory accessibility and nutritive values of multigrain flour mixture products. International Journal of Health Sciences and Research. 6(1): 459-465.

Annapurna, A. (2011). Health benefits of Barley. Journal of Pharmaceutical Research and Health Care. 3(2): 22.

AOAC (2000). Official Methods of Analysis, 17th edition. Association of Official Analytical Chemists, Washington, DC.

Chang, K.L. and Bray, R.H. (1951). Determination of calcium and magnesium in soil and plant material. Soil Science. 72(5): 449-58.

David, B.M., Michael, A., Doyinsola, O., Patrick, I. and Abayomi, O. (2014). Proximate composition, mineral and phytochemical constituents of *Eleusine coracana* (finger millet). International Journal of Advanced Chemistry. 2(2): 171-174.

Del Rosario, R.R. and Flores, D.M. (1981). Functional properties of four types of mung bean flour. Journal of the Science of Food and Agriculture. 32(2): 175-180.

Directorate of Economics and Statistics. Department of Agriculture, Cooperation and Farmers welfare, Government of India (2018-19). https://eands.dacnet.nic.in

Gutte, K.B., Sahoo, A.K. and Ranveer, R.C. (2015). Bioactive components of flaxseed and its health benefits. International Journal of Pharmaceutical Sciences Review and Research. 31(1): 42-51.

Indian Institute of Millets Research (2017). https://iimr.icar.gov.in.

Jukanti, A.K., Gaur, P.M., Gowda, C.L.L. and Chibbar, R.N. (2012) Nutritional quality and health benefits of chickpea (*Cicer arietinum* L.): A review. British Journal of Nutrition. 108(S1): S11-S26.

Lindsay, W.L. and Norvell, W.A. (1978). Development of a DTPA soil test for zinc, iron, manganese and copper. Soil Science Society of America Journal. 42(3): 421-428.

Noorfarahzilah, M., Lee, J.S., Sharifudin, M.S., Mohd Fadzelly, A.B. and Hasmadi, M. (2014). Applications of composite flour in development of food products. International Food Research Journal. 21(6): 2061-2074.

Wang, J.C. and Kinsella, J.E. (1976). Functional properties of novel proteins; alfalfa leaf protein. Journal of Food Science. 41: 286-289.

https://www.indiastat.com/table/agriculture/area-production-productivity