Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(2): 733-736
Received: 01-01-2018
Accepted: 02-02-2018

Charul Chaudhary
Assistant Professor, Food Processing & Preservation, DEI, Agra, Uttar Pradesh, India

Aneeta Khatak
Ph.D student, Centre of Food Science and Technology, CCSHAU, Hisar, Haryana, India

RB Grewal
Director, Centre of Food Science and Technology, CCSHAU, Hisar, Haryana, India

Dipti Rai
Assistant Professor, Department of Food Technology, CSJM University, Kanpur, Uttar Pradesh, India

Correspondence
Dipti Rai
Assistant Professor, Department of Food Technology, CSJM University, Kanpur, Uttar Pradesh, India

Physical functional and nutritional properties of different cereals and flaxseed

Charul Chaudhary, Aneeta Khatak, RB Grewal and Dipti Rai

Abstract
The physical, functional and nutritional properties of selected cereals (viz., wheat, corn, oat and barley) and flaxseed were studied. Thousand seeds weight, bulk density, hydration capacity, hydration index, swelling capacity and swelling index of cereals i.e. wheat, corn, barley and oat ranged from 26.88 to 256.1 g, 0.50 to 0.83 g/ml, 0.02 to 0.09 g/seed, 0.37 to 0.69, 0.01 to 0.09 ml/seed and 0.28 to 0.57, respectively. The functional properties including water absorption capacity (266.7%), gelation capacity (15%), emulsification capacity (58.82%) and swelling power (125.4%) were observed high in flaxseed. The moisture, crude protein, crude fat, ash and crude fibre of cereal grains (wheat, corn, barley and oat) varied between 7.85-10.9 g, 10.43-14.07 g, 1.38-5.63 g, 1.68-3.03 g, 1.37-3.74 g, 78.39-84.71 g and 383.9-412.5 kcal per 100 g, respectively. Crude protein, crude fat, crude fiber and energy content were found high in flaxseed as compared to cereals.

Keywords: cereals, flaxseed, physical, functional, nutritional properties.

Introduction

Food products are generally prepared using corn, wheat or rice. The major functions of these ingredients are to give texture, structure, mouth feel, bulk, and many other characteristics desired for specific finished products (Launay & Lisch, 1983).[17] However, they tend to be low in protein with a poor biological value because of their limited essential amino acid contents (Prinyawiwatkul *et al*., 1996). The search for novel high-quality but cheap sources of protein and energy has been attaining popularity in developing countries for meeting the challenges of hunger and starvation. There are many epidemiological studies which provided strong evidence that risks posed by chronic diseases can be reduced by consumption of staple food with functional constituents. The attention has been focused on flaxseed, oat and barley grains containing relatively high amounts of proteins that can help to enhance the quality of the foods of a large segment of population (Apata, 1990). [5]

The flaxseed (*Linum usitatissimum* L.) is a Rabi crop and is a member of Linaceae family, commonly known as “Alsi” (Gujrati, Hindi and Punjabi). Flaxseed is gaining popularity in the food sector for its functional properties, since it is a rich source of essential fatty acids, protein, lignans, vitamins and minerals (Muir & Westcott, 2003). [21] It contains approximately 40% lipid of which 47–57% is ALA (Daun & Przybylski, 2000) and other healthful components such as dietary fiber (28%) and secoisolariciresinol diglucoside (SDG), a lignan (Carter, 1993).[6]

Barley (*Hordeum vulgare*) is the fourth most important cereal in terms of world production after wheat, rice and corn. It is an important coarse cereal in India. The predominant type of barley cultivated is hulled having a tough fibrous husk and is used as a malting, brewing grain and as cattle feed. The other type is the hull-less or naked barley in which the hull is easily removed during threshing similar to wheat. Barley is an exceptional source of bioactive constituents, including vitamin E, B-complex vitamins, enzymes, minerals and phenolic compounds. In-spite of these interesting characteristics barley remain underutilized crop in human foods, except for the malting, brewing and distilling industries (Jadhav *et al.*, 1998).[13]

Flaxseed, oats and barley has gain importance as food due to their perceived nutritional benefits, since they are rich source of essential fatty acids, lignans, Beta glucan, vitamins and minerals. The effective use, attributes and consequent acceptance of flours by consumers are dependent on its functional properties and the degree of starch gelatinization. Hence, the present study aims to assess the physical, functional and nutritional characteristics of different cereals and flaxseed and its utilization for product formulation.

Materials and methods Hull-less barley, hulled barley, oat (HJ-8 and OS-6 variety) and wheat (WH-1105) were procured from the Department of Genetics and Plant Breeding CCSHAU, Hisar. Corn (HQPM-1) was procured from the Regional Research Station, Uchani, Karnal. Flaxseed were procured from local market.

Preparation of cereal grains and flaxseed flour

Cereal grains (wheat, corn, oat and barley) and flaxseed were cleaned, conditioned, dried and grounded to flour.

Physical properties of cereal grains and flaxseed

Cereal grains (wheat, corn, oat and barley) and flaxseed were evaluated for the physical properties i.e.1000 kernel weight, bulk density, hydration capacity, hydration index, swelling capacity, swelling index and dimensions.

1000 kernel weight

1000 kernel weight was measured by counting 100 randomly selected seeds. The seeds were weighed using an electronic balance having an accuracy of 0.001 g and weight was multiplied by 10 to give weight of 1000 kernels.

Bulk density

Bulk density was determined according to the method described by Okaka & Potter (1977). [24]50 g

Hydration capacity

Hydration capacity, swelling capacity, hydration index and swelling index was determined according to the method described by Williams *et al*. (1983). [31]

Dimensions

For each seed, two principal dimensions; length (L) and width (W) were measured using a digital vernier caliper to an accuracy of 0.02 mm.

Functional properties

The cereal flour and flaxseed powder was assessed for the water absorption capacity, gelation capacity, emulsification capacity, flour solubility, swelling power, foam capacity and stability

Water absorption capacity

Water absorption capacity was determined by the method of Singh and Singh (1991). [28]

Gelation capacity

The gelation capacity was determined according to the method of Singh & Singh (1991). [28]

Emulsification capacity

Emulsification capacity was determined using the procedure described by Kinsella (1979).

Flour solubility

Flour solubility was determined by the method of Subramanian *et al*. (1986).

Swelling power

Swelling power of the flour was determined by the method of Subramanian *et al*. (1986). [29]

Foam capacity and stability

The method described by Narayana & Narasinga Rao (1982), [22] modified by Fagbemi & Oshodi (1991) was used to determine the foam capacity and foam stability.

Nutritional properties

Different cereals and flaxseed was tested for moisture, crude protein, crude fat, crude fiber, ash, by employing the standard methods of analysis (AOAC, 1995). [4] The carbohydrate content was calculated by difference.

Results and discussion

The physical parameters like thousand grain weight, bulk density, hydration capacity, hydration index, swelling capacity, swelling index and dimensions were assessed and the results are presented in Table 1. Thousand seeds weight of corn was highest (256.1 g) followed by wheat (37.60 g), barley (38.02 and 33.72 g), oats (26.88 and 27.74 g) and flaxseeds (07.39 g). Thousand seeds weight of corn was significantly ($P<0.05$) higher than other cereals studied. However, thousand seeds weight of flaxseed was significantly ($P<0.05$) lower as compared to cereals. Similar value for thousand seed weight of flaxseed has been reported by Khan & Saini (2016). The results obtained for the thousand seed weight of corn and barley is in agreement with those reported by Makeri *et al*. (2013) and Abiose & Ikujenlola (2014). Bulk density of cereal grains and flaxseed varied from 0.50 to 0.83 g/ml. Makeri *et al.* (2013) documented higher bulk density (1.10-1.16 g/ml) of barley cultivars than obtained in present study. Sharma & Prasad (2013) reported higher value for bulk density of different linseed varieties ranging from 1006 to 1198 kg/m^3 than recorded in present study. Hydration capacity and swelling capacity of corn was significantly ($P<0.05$) higher than wheat, barley, oat and flaxseed. The results obtained for the hydration and swelling capacity of cereal grains are in agreement with those reported by Nutan (2015). Swelling index of wheat was significantly ($P<0.05$) higher than other cereals studied. No significant difference in swelling index of corn, hulled barley and oat variety (OS-6) was witnessed. Swelling index of flaxseed was also highest and significantly ($P<0.05$) higher than cereals studied. The results obtained for the hydration and swelling index of cereal grains are conflicting with those reported by Guria (2006). [10] Length of oat was significantly higher than other cereals studied. However, length of flaxseed was significantly ($P<0.05$) lower as compared to cereals. Width of corn was significantly higher than other cereals studied. Length (5.42 mm) of flaxseed reported in present study is in close agreement with the results of Khan & Saini (2016). [15]

Data regarding water absorption capacity, gelation capacity, emulsification capacity, flour solubility, swelling power and foaming capacity of cereals (wheat, corn, oat and barley) and flaxseed has been presented in Table 2. Water absorption capacity of cereals (wheat, corn, oat and barley) ranged from 094.4-166.7%. HJ-8 variety of oat showed highest water absorption capacity followed by corn, OS-6 variety of oat, hulled barley, hull-less barley and wheat. Gelation capacity of hulled barley was highest followed by hull-less barley, wheat, corn, OS-6 variety of oat and HJ-8 oat variety. Gelation capacity of barley (Hull-less or hulled) was significantly higher than wheat, corn and oat. No significant difference in gelation capacity of wheat, corn and oat was recorded. Emulsification capacity of wheat, corn, hull-less barley, hulled barley, HJ-8 variety of oat and OS-6 variety of oat were 08.82, 24.51, 05.88, 07.79, 01.47, and 04.41%. Flour solubility of wheat was highest followed by hull-less barley, hulled barley, corn, OS-6 variety of oat and HJ-8 variety of oat. Swelling power of wheat, corn, oat and barley ranged from 109.9-112.1%. No-significant difference in swelling power of wheat, corn and oat (HJ-8) were noticed. Foaming capacity of hull-less barley was highest followed by hulled barley, wheat, HJ-8 oat variety, corn and OS-6 variety of oat. Water absorption capacity (266.7%), gelation capacity (15%), emulsification capacity (58.82%) and swelling power (125.4%) of flaxseed was significantly (P<0.05) higher whereas, flour solubility was significantly lower than the cereals studied. Foaming capacity could not be detected in flaxseed. Similarly, foaming stability of cereal flour (wheat, corn, oat and barley) and flaxseed powder was not detected. It is evident that cereal flour and flaxseed powder foams were not stable. The functional properties of cereal grains and flaxseed are in agreement with those reported by previous studies according to Adebowale *et al.* (2012), [3] Adebayo *et al.* (2013), [2] Chandra & Samsher, (2013), [7] Shad *et al.* (2013), [26] Inglett *et al.* (2013) [12] and Jagannadham *et al.*, (2014).[14]

The chemical composition of selected cereals and flaxseed are given in Table 3. Corn contained highest moisture content followed by hulled barley, wheat, OS-6 variety of oat, hull-less barley, and HJ-8 variety of oat. Among the cereals crude protein content reported to be high in hull-less barley (14.07%) followed by HJ- variety of oat (13.47%), hulled barley (11.48%), corn (11.11%), OS-6 variety of oat (10.61%) and wheat (10.43%). Similarly, Vasan (2015) [30] and Malik *et al.* (2015) investigated higher protein in barley than wheat. Crude fat content of oat was significantly (P<0.05) higher than corn, barley and wheat. Hulled barley contained significantly (P<0.05) higher ash and crude fiber content than other cereals. Wheat contained highest carbohydrates content followed by hull-less barley, corn, OS-6 variety of oat, hulled barley, and HJ-8 variety of oat. Carbohydrate content of wheat was significantly higher than corn. The results obtained are similar to the results reported by Inglett *et al*. (2014) and Malik *et al*. (2015). Energy content of OS-6 variety of oat was highest followed by HJ-8 variety of oat, corn, wheat, hull-less barley and hulled barley. Corn contained significantly (P<0.05) higher energy content than wheat. Flaxseed contained 16.80 g crude protein, 37.43 g crude fat, 2.85 g ash, 8.27 g crude fiber, 34.65 g carbohydrate and 542.78 kcal energy per 100 g (Table 3). Crude protein, crude fat, crude fiber and energy content of flaxseed was significantly (P<0.05) higher than the cereal grains whereas, ash and carbohydrate content of flaxseed was significantly lower (P<0.05) than the cereal grains studied. Similar results were obtained by Hejazi (2014); [11] Marpalle *et al.* (2014); [20] Malik *et al.* (2015); [19] and Khan & Saini (2016). [15]

Table 1: Physical properties of cereals and flaxseed

Sample		1000-kernel weight (g)	Bulk density (g/ml)	Hydration capacity (g/seed)	Hydration index	Swelling capacity (ml/seed)	Swelling index	Dimensions (mm)	
								Length	Width
Wheat		37.60±0.94	0.83±0.00	0.02±0.00	0.51±0.01	0.02±0.00	0.57±0.06	06.18±0.10	3.07±0.02
Corn		256.1±2.53	0.72±0.02	0.09±0.00	0.37±0.01	0.09±0.00	0.47±0.04	10.45±0.18	8.90±0.33
Barley	Hull-less	38.02±0.49	0.75±0.01	0.02±0.00	0.43±0.02	0.02±0.00	0.55±0.09	08.41±0.10	3.37±0.24
	Hulled	33.72±1.00	0.58±0.02	0.02±0.00	0.59±0.01	0.01±0.00	0.39±0.07	09.05±0.10	3.48±0.14
Oat	HJ-8 variety	26.88±0.34	0.50±0.00	0.02±0.00	0.69±0.01	0.01±0.00	0.44±0.05	13.40±0.38	2.79±0.06
	OS-6 variety	27.74±0.48	0.52±0.01	0.02±0.00	0.57±0.04	0.01±0.00	0.28±0.01	12.18±0.07	2.64±0.16
Flaxseed		07.39±0.06	0.70±0.01	0.01±0.00	1.07±0.09	0.01±0.00	1.28±0.06	05.42±0.11	2.69±0.01
CD at 5%		2.00	0.02	0.01	0.07	0.01	0.13	0.39	0.38

Values are mean± S.D of three replicates

Tables 2: Functional properties of cereals flour and flaxseed powder

Sample		Water absorption capacity (%)	Gelation capacity (%)	Emulsification capacity (%)	Flour solubility (%)	Swelling power (%)	Foaming capacity (%)
Wheat		094.4±9.62	8.00±0.00	08.82±0.00	18.67±0.58	110.8±0.49	22.04±0.48
Corn		155.6±19.3	8.00±0.00	24.51±3.70	13.67±2.52	111.5±0.40	13.32±1.56
Barley	Hull-less	102.2±3.81	8.83±0.29	05.88±0.00	15.33±1.53	111.7±0.20	28.60±2.77
	Hulled	103.3±5.77	9.17±0.29	07.79±0.53	14.67±1.53	109.9±0.40	27.32±2.31
Oat	HJ-8 variety	166.7±0.00	8.00±0.00	01.47±0.00	07.33±0.58	110.8±0.52	16.01±1.13
	OS-6 variety	105.6±9.62	7.50±0.00	04.41±0.00	09.00±0.00	112.1±0.52	11.32±1.50
Flaxseed		266.7±0.00	15.00±0.00	58.82±0.00	10.67±0.58	125.4±0.61	ND
CD at 5%		16.42	0.27	2.50	2.32	0.83	2.93

Table 3: Proximate composition and energy of cereals and flaxseed (per 100g on DM basis)

Sample		Moisture (g)	Crude protein (g)	Crude fat (g)	Ash (g)	Crude fibre (g)	Carbohydrates (g)	Energy (kcal)
Wheat		9.15±0.08	10.43±0.29	1.53±0.15	1.68±0.28	2.04±0.20	84.71±0.37	394.4±0.65
Corn		10.9±0.11	11.11±0.18	4.30±0.20	1.77±0.20	2.17±0.15	80.66±0.32	405.8±1.60
Barley	Hull-less	8.14±0.12	14.07±0.49	1.38±0.21	2.43±0.13	1.43±0.05	80.69±0.35	391.5±1.03
	Hulled	9.95±0.46	11.49±0.13	2.19±0.05	3.03±0.06	3.74±0.08	79.55±0.21	383.9±0.34
Oat	HJ-8 variety	7.85±0.22	13.47±0.06	4.63±0.25	2.13±0.18	1.37±0.05	78.39±0.14	409.2±1.86
	OS-6 variety	8.33±0.50	10.61±0.13	5.63±0.28	2.33±0.08	1.57±0.04	79.85±0.33	412.5±1.33
Flaxseed		4.22±0.38	16.80±0.24	37.4±0.50	2.85±0.10	8.27±0.26	34.65±0.48	542.8±3.18
CD at 5%		0.55	0.45	0.47	0.29	0.25	0.58	3.00

Values are mean± S.D of three replicates

Conclusion

This investigation concluded that flaxseed, oats and barley possess good functional and nutritional properties. Hence, a variety of innovative healthy products may be developed to suit the consumer needs and also to achieve nutrition security.

Acknowledgement

Author express sincere thanks to Department of Science & Technology (DST), Govt. of India for providing financial assistance in the form of INSPIRE fellowship (JRF & SRF).

References

1. Abiose SH, Ikujenlola AV. Comparison of chemical composition, functional properties and amino acids composition of quality protein maize and common maize (*Zea may* L*)*. African J Food Sci. Technol. 2014; 5(3):81-89.
2. Adebayo OR, Olayiwola O, Abidemi S, Abdulsalam S. Functional properties and anti-nutritional factors of some selected Nigerian cereals. Comp. Res. J Agric. Sci. 2013; 1(1):001-005.
3. Adebowale AA, Adegoke MT, Sanni SA, Adegunwa MO, Fetuga GO. Functional properties and biscuit making potentials of sorghum-wheat flour composite. American J Food Technol. 2012; 7:372-379.
4. AOAC. Official methods of analysis 15th Edn. Association of official Analytical Chemist Washing, DC. 1995.
5. Apata DF. Biochemical, nutritional and toxicological assessment of some tropical legume seeds. *Ph. D Dissertation*, Department Animal Science University Ibadan, Nigeria. 1990.
6. Carter JF.Potential of flaxseed and flaxseed oil in baked goods and other products in human nutrition. *Cereal Foods* World. 1993; 38(10):753-759.
7. Chandra S, Samsher. Assessment of functional properties of different flours. African J. Agri. Res. 2013; 8(38):4849-4852.
8. Daun JK Przybylski R. Environmental effects on the composition of four Canadian flax cultivars. In Proceeding of the 58th Flax Institute, USA, 2000, 80-91.
9. Fagbemi TN, Oshidi AA. Chemical composition and functional properties of full fat fluted pumpkin seed flour. Nigeria Food J 1991; 9:26-32.
10. Guria P. Physico-chemical properties, nutritional quality and value addition to quality protein maize (*Zea mays* L.). *M.Sc. Thesis*, University of Agricultural Sciences, Dharwad, Karanataka, India. 2006.
11. Hejazi MA. Using Hull-less barley and flax seeds flour to produce macaroni for hyperglycemia disease in rats. Life Sci. J 2014; 11(2):354-361.
12. Inglett GE, Chen D, Liu S. Properties of amaranth flour with functional oat products. J. Food Res. 2014; 3:6.
13. Jadhav SJ, Lutz SE, Ghorpade VM, Salunkhe DK. Barley: chemistry and value-added processing. *Criti.* Rev. Food Sci. 1998; 38(2):123-171.
14. Jagannadham K, Parimalavalli R, Babu AS, Rao JS. A study on comparison between cereal (wheat) and non cereal (chickpea) flour characteristics. Int. J Cur. Tr. Res. 2014; 3(2):70-76.
15. Khan A, Saini CS. Effect of roasting on physicochemical and functional properties of flaxseed flour. *Cogent Eng.* 2016; 3:1-14.
16. Kinsella JE. Functional properties of soy proteins. J Am. Oil Chem. Soc. 1979; 56(3):219.
17. Launay B, Lisch JM. Twin-screw extrusion cooking of starches: Flow behaviour of starch pastes, expansion and mechanical properties of extrudates. J. Food Eng. 1983; 2:259-280.
18. Makeri MU, Nkama I, Badau MH Physico-chemical, malting and biochemical properties of some improved Nigerian barley cultivars and their malts. Int. Food Res. J. 2013; 20(4):1563-1568.
19. Malik H, Nayik GA, Dar BN. Optimization of process for development of nutritionally enriched multigrain bread. J Food Proc. Technol. 2015; 7(1):544.
20. Marpalle P, Sonawane SK, Arya SS. Effect of flaxseed flour addition on physicochemical and sensory properties of functional bread. *LWT*-Food Sci. Technol. 2014; 58:614-619.
21. Muir AD, Westcott ND. Flaxseed Constituents and Human Health. In: Muir, A.D. and Westcott, N.D. (eds.). Flax: The Genus *Linum*. Taylor & Francis, London. 2003; 243-251.
22. Narayana K, Narasinga Rao MS. Functional properties of raw and heat processed winged bean flour. J Food Sci. 1982; 42:534-538.
23. Nutan. Nutritional and sensory evaluation of value added products developed from maize-oat-tulsi flour blends. *Ph.D. Thesis*, CCS Haryana Agricultural University, Hisar, India. 2015.
24. Okaka JC, NN Potter. Functional and storage properties of cowpea-wheat flour blends in bread making. J Food Sci. 1977; 42:822-833.
25. Prinya wiwatkul WMC, waters KH, Beuchat LR, Phillips RD. Cowpea flour: a potential ingredient in food products. Critical Reviews in Food Science and Nutrition, 1996; 36:413.
26. Shad MA, Nawaz H, Noor M, Ahmad HB, Hussain M, Choudhry MA. Functional properties of maize flour and its blends with wheat flour: optimization of preparation conditions by response surface methodology. Pak. J Bot. 2013; 45(6):2027-2035.
27. Sharma S, Prasad K. Comparative physical characteristics of linseed (*Linum usitatissimum*) Kernels. Int. J Agri. Food Sci. Technol. 2013; 4(7):671-678.
28. Singh U, Singh B. Functional properties of sorghum-peanut composite flours. *Cereal Chem.* 1991; 68:460-463.
29. Subramanian V, Jambunathan R, Ramaiah CD. Physical and chemical characteristics of pearl millet grains and their relationship to roti quality. J Food Sci. 1986; 5(4):1005-1008.
30. Vasan A. Development of Value Added Products Based on Barley (*Hordeum vulgare*) and their Nutritional Evaluation. *Ph.D. Thesis*, CCS Haryana Agricultural University, Hisar, India. 2015.
31. Williams PC, Nakoul H, Singh KB. Relationship between cooking time and some physical characteristics in chickpea (*Cicer arietinum L*). J Sci. Food. Agric. 1983; 34:492-496.