Int.J.Curr.Microbiol.App.Sci (2020) *9*(11): 3868-3874

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 9 Number 11 (2020)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2020.911.462

Studies on Effect of Partial Hydrolysis on Functional Properties of Ispaghula Husk

S. D. Katke[1*], H. W. Deshpande[1], B. S. Agarkar[2], R. B. Kshirsagar[2] and K. S. Gadhe[3]

[1]Department of Food Microbiology and Safety, [2]Department of Food Engineering, [3]Department of Food Chemistry and Nutrition, College of Food Technology, VNMKV, Parbhani, Maharashtra, India

**Corresponding author*

Keywords

Plantago ovata, Isabgol, Ispaghula, Blond psyllium, Hydrolyzed Ispaghula Husk

Article Info

Accepted:
24 October 2020
Available Online:
10 November 2020

A B S T R A C T

In the present investigation, sincere efforts have been made to standardize the process for partial hydrolysis of ispaghula husk or psyllium husk by using hydrochloric acid. At the reaction temperature of 37.5°C, ispaghula husk was treated with 0.50 %, 0.55 % and 0.60 % of (34 % to 37 %) hydrochloric acid (HCl) in ethanol as a solvent in three different ispaghula husk : solvent ratios (1:3, 1:5 and 1:7 g/mL). Based on the results of partial hydrolysis on functional properties of ispaghula husk, acid concentration of 0.60 % HCl in the ispaghula husk : solvent ratio of 1:7 was selected to be incorporated in different value added food products.

Introduction

Plantago ovata commonly known as 'Psyllium' in English and '*Ispaghula* or *Isabgol*' in Hindi belongs to the family of *Plantaginaceae*, is a 10-45 cm short-stemmed annual herb known by different names such as *ashwagolam*, *aspaghol*, *aspagol*, *blond psyllium*. It is commercially an important Rabi season crop known for its medicinal properties. Apart from its husk (seed coat is known as "husk") it is also being used in food industry for different food products. The crop is mainly cultivated in the states of Rajasthan, Gujarat, Haryana and Madhya Pradesh. Among medicinal plants, Isabgol is the first ranked foreign exchange earner for the country. Notably, India ranks first in isabgol production (98%) and is the sole supplier of seeds and husk in the international market. USA is the chief importer of isabgol seeds and husk. The husk is about 10-25 percent of seed on dry weight basis. The husk obtained after milling is white hydrophilic material forming clear and colorless mucilaginous gel after water absorption. The seeds of psyllium are used commercially for the production of mucilage. The mucilage obtained from the seed coat by mechanical milling or grinding of the outer layer of the seeds. Psyllium seed husk is composed of mucilaginous polysaccharides, with a highly branched acidic arabinoxylan containing a xylan backbone (Blumenthal *et al.,* 2000).

Among various aforesaid dietary fibers, ispaghula husk obtained from *Plantago ovata* plant is a common source of soluble fiber used in traditional Indian system of ayurvedic medicines for prevention of skin irritations, hemorrhoids, constipation as well as diarrhea. It is a gel forming mucilage known for its laxative effect due to its high-water holding capacity which is approximately 30 times of its weight. The seed husk contains about 78 percent soluble fibres and 13 percent insoluble fibres (Yu and Perret, 2003). The husk of psyllium contains a high level (62-63 percent) of a complex heteroxylan with arabinose and xylose as main monosaccharide, which is further referred to as Arabinoxylan (Fischer *et al.,* 2004, Marlett and Fischer 2002). Apart from treatment of irritable bowel syndrome and constipation, various other therapeutic effects of ispaghula husk proved by scientific studies include reducing LDL-cholesterol level, reducing hyperglycemia, reducing risk of colon cancer, weight management (Singh, 2007). Also, its prebiotic effects have been studied and it has been found that on consumption of partially hydrolyzed psyllium short chain fatty acids are produced in colon and thus promote the growth of probiotic microbes (Elli *et al.,* 2008). Health claims on the beneficial effects of PSH, approved in 1998 by the US Food and Drug Administration, have led to the inclusion of PSH in cereals and fibre supplements (Luccia and Kunkel 2002). The addition of psyllium to a traditional diet for persons with diabetes is safe, is well tolerated, and improves glycemic and lipid control in men with type 2-diabetes and hypercholesterolemia (Anderson *et al.,* 2000). However, its strong water-absorbing and gelling properties make it difficult to handle and process, and present a real challenge when incorporating in food and beverage formulas (Yu and Perret 2003). Studies on the effect of acid treatment on water up-taking, swelling, gelling and bile acid binding capacities of PH samples, indicated that reaction temperature influenced the effectiveness of acid treatment on physical and chemical properties of psyllium samples significantly. This implicated the acid hydrolysis at a high temperature might be a possible method to improve the physical and chemical properties of psyllium for incorporation in food (Xiaoyin Pei, 2008 and Liangli Yu, 2000).

Acid hydrolysis presents a competitive potential of being applied in food industry due to its lower cost than enzymatic methods. Based on the previous studies as mentioned earlier, an attempt had been made to improve the physical and chemical properties of psyllium for incorporation in foods by acid treatment of the raw ispaghula husk, so that it will serve as a source of dietary fiber without disturbing the nutritional and sensorial characteristics of the husk incorporated processed food products.

Materials and Methods

Procurement of Raw Material

Ispaghula Husk (98 percent pure) of indigenous variety was purchased from local market. The husk was grounded into powder and sieved through 40 mesh size. The powder was stored in plastic air tight container till use.

Proximate composition

Proximate composition such as moisture, fat, crude protein, ash and crude fiber were determined as per A.O.A.C. 1995 and carbohydrate by difference method.

Mineral composition

Iron, Copper, Manganese and Zinc in acid digested samples were determined by Atomic Absorption Spectrophotometer according to the method of Lindsey and Norwell, (1969).

Dietary Fibre

Determination of dietary fibre was done using the method described by Prosky *et al.*, (1992).

Functional Properties

Oil absorption and hydration capacities were determined by the method of Rosario and Flores (1981). Water uptake rate was determined by the method described by Yu and Perret (2003).

Partial hydrolysis of ispaghula husk

Partial hydrolysis of Ispaghula husk was carried out as per the method described by Xiaoyin Pei (2008) and Syed *et al.*, (2018) with certain changes in concentration of hydrochloric acid in ethanol solvent. The solvent used for ispaghula husks treatment was ethanol with 34 % to 37 % hydrochloric acid (HCl) at the varying concentration levels of 0.50 %, 0.55 % and 0.60 % (w/v). The study was conducted to investigate the effect of ispaghula-solvent ratio and reaction temperature on physico-chemical and functional properties of the acid hydrolyzed ispaghula samples.

At reaction temperature of 37.5°C three different ispaghula-solvent ratios (1:3, 1:5 and 1:7) were tested. After the addition of the solvent, samples were incubated for 48 hours at 37.5°C temperature. Afterward, samples were vacuum filtered, rinsed with 95 % ethanol for 2 times each, then dried and stored. Control group was treated with 100 % ethanol and followed the steps of preparation mentioned in Table 1.

Results and Discussion

The results shown in Table 2 revealed that, the moisture content of native ispaghula husk was 7.18 percent on whole weight basis, fat content was 1.85 percent and protein content was 2.94 percent. It is clear from the Table 2 that ash and total carbohydrate content of native ispaghula husk were found to be 2.61 percent and 85.42 percent respectively. Calculated energy value was found 372 Kcal/100g. The results were in close agreement with the finding of Guo *et al.*, (2008).

It is revealed from Table 3 that iron and copper content of native ispaghula husk was found to be 8.00 mg/100 g and 0.675 mg/100 g respectively while manganese and zinc content was found to be 0.600 mg/100 g and 0.325 mg/100 g. Iron content was found highest among the minerals assessed.

The data presented in Table 4 shows the various functional properties of native ispaghula husk. The hydration capacity of native ispaghula husk was found to be 3.1 ml/g while the oil absorption capacity was found 1.1 ml/g. However, it is clearly revealed from Table 4 that water up-taking rate of native ispaghula husk was found to be 2.22 mg/g x min Kamaljit *et al.,* (2011) reported similar findings for native ispaghula husk functional properties as an ingredient for high fibre bread.

Table.1 Acid hydrolysis levels for ispaghula husk

Concentration of HCl in Ethanol Solvent	Ispaghula Husk (PH) : Solvent Ratio
0.50 %	1:3, 1:5 and 1:7 (w/v)
0.55 %	1:3, 1:5 and 1:7 (w/v)
0.60 %	1:3, 1:5 and 1:7 (w/v)
Control	1:3, 1:5 and 1:7 (w/v)

Table.2 Proximate composition of ispaghula husk

Parameters (%)	Native Ispaghula Husk (NIH)
Moisture	7.18
Fat	1.85
Protein (N x 6.25)	2.94
Ash	2.61
Carbohydrate	85.42
Dietary Fibre	76.66
Energy value	372 Kcal / 100g

Table.3 Mineral composition of ispaghula husk

Minerals (mg/100 g)	Native Ispaghula Husk (NIH)
Iron (Fe)	8.00
Copper (Cu)	0.675
Manganese (Mn)	0.600
Zinc (Zn)	0.325

Table.4 Functional properties of native ispaghula husk

Parameters	Native Ispaghula Husk (NIH)
Hydration capacity (ml/g)	3.1
Oil absorption capacity (ml/g)	1.1
Water up-taking rate [mg/(g×min)]	2.22

Table.5 Effect of acid hydrolysis on functional properties of ispaghula husk

Functional properties	Ispaghula Husk : Ethanol Ratio	Concentrationof HCl in Ethanol (%)			
		Control	0.50	0.55	0.60
Hydration capacity (ml/g)	1:3	2.88	2.70	2.50	2.12
	1:5	2.83	2.65	2.38	1.82
	1:7	2.79	2.62	2.29	1.62
Oil absorption capacity (ml/g)	1:3	0.91	0.80	0.63	0.52
	1:5	0.89	0.73	0.60	0.51
	1:7	0.84	0.61	0.54	0.50
Water up-taking rate [mg/(g×min)]	1:3	2.11	1.90	1.81	1.73
	1:5	2.01	1.88	1.78	1.71
	1:7	1.92	1.85	1.76	1.68
SE ±		0.37	0.02	0.17	0.16
CD @ 5%		1.11	0.07	0.50	0.49

Table.6 Effect of acid hydrolysis on proximate composition of ispaghula husk

Particulars (g/100g)	Hydrolyzed Ispaghula Husk
Moisture	7.35
Fat	0.62
Protein	1.21
Ash	2.24
Carbohydrate	88.55
Dietary Fiber	79.66
Energy Value	367 Kcal/100g

Table.7 Effect of acid hydrolysis on hardness and adhesiveness of selected acid hydrolyzed ispaghula husk

Particulars	Hardness (g)	Adhesiveness (-g)
Native Ispaghula Husk	88.0	11.0
Hydrolyzed Ispaghula Husk	55.0	9.0

Effect of acid hydrolysis on functional properties of ispaghula husk

It is revealed from the Table 5 that the hydration capacity of ispaghula husk was decreased with the increased level of acid concentration used for treatment from 2.88 to 1.62 ml/g. Significant decrease in hydration capacity were observed in case of ispaghula husk sample treated with 0.60% acid concentration having lowest 1.62 ml/g for 1:7 ratio. It can be observed from the Table 5 that the oil absorption capacity of 0.60 % acid treated ispaghula husk for the ispaghula husk :

solvent ratio as 1:7 was found to be lowest as 0.50 ml/g. The data from the Table 5 indicates that the OAC of treated ispaghula husk decreased with the increased level of acid concentration from 0.91 ml/g to 0.50 ml/g. The data from the Table 5 indicates that water up-taking rate is lowest for 0.60 % acid treated ispaghula husk for the ispaghula husk : solvent ratio as 1:7 sample as 1.68 mg/(g×min).

Based on the results of acid hydrolysis on functional properties of ispaghula husk, acid hydrolysis concentration of 0.60 % HCl in the ethanol solvent for solvent ratio of 1:7 as ispaghula husk : solvent ratio, had been selected considering previous reported studies for further studies on its effect on proximate composition and utilization in food products.

Effect of acid hydrolysis on proximate composition of selected acid hydrolyzed ispaghula husk

The results related to the effect of acid hydrolysis of the selected concentration of HCl in ethanol i.e., 0.60 % (0.60 ml of 34 % - 37 % concentrated hydrochloric acid (HCl) in 100 ml pure ethanol) based on the assessment of functional properties of ispaghula husk such as oil absorption, hydration capacity and water uptake rate on proximate composition of ispaghula husk are shown in Table 6.

It can be observed from Table 6 that moisture content increased from 7.18 to 7.35 per cent upon acid hydrolysis. Fat content decreased after acid hydrolysis from 1.85 to 0.62 per cent while protein content decreased from 2.94 to 1.21 per cent. Similarly, ash and protein decreased from 2.61 to 2.24 and 2.94 to 1.21 per cent respectively. The decrease in fat, protein, and ash content resulted due to the partial degradation of the psyllium gel hardness because of acid hydrolysis. Further, carbohydrate content increased from 85.42 to 88.55 per cent and energy value decreased from 372 to 367 Kcal/100g.

Effect of acid hydrolysis on hardness and adhesiveness of selected acid hydrolyzed ispaghula husk

Gelling properties were analyzed using TA-*XT2 PLUS* Texture Analyzer (Stable Micro System, Surrey, UK) having 60 kg load cell was used for Texture profile analysis (TPA). Measurements were performed with a pretest speed of 2.0 mm/sec, a test speed of 5.0 mm/sec, a post test speed of 5.0 mm/sec, and a distance of 6 mm. All measurements were made in triplicate. Two and one-half grams (2.5 g) of ispaghula husk (40 mesh) was added to 50 ml. of distilled water kept for overnight and this was used to compare the gelling and water-absorbing properties of modified ispaghula husk. The results were expressed as in gram force for hardness and adhesiveness. All results are shown in Table 7.

Hardness and adhesiveness are the maximum force (g) measured on for peaks of the "texture profile" graph provided according to analytical testing with a texture analyzer. These properties correspond to the first positive peak and the first negative peak. Comparative data of hardness and adhesiveness from Table 7 indicates that there was a substantial decrease in hardness and adhesiveness of the acid hydrolyzed ispaghula husk.

In the present investigation, sincere efforts have been made to standardize the process for partial hydrolysis of ispaghula husk or psyllium husk by using hydrochloric acid. At the reaction temperature of 37.5°C, ispaghula husk was treated with 0.50 %, 0.55 % and 0.60 % of (34 % to 37 %) hydrochloric acid (HCl) in ethanol as a solvent in three different ispaghula husk : solvent ratios (1:3, 1:5 and 1:7 g/mL). Based on the results of partial hydrolysis on functional properties of ispaghula husk, acid concentration of 0.60 %

HCl in the ispaghula husk : solvent ratio of 1:7 was selected to be incorporated in different value added food products.

References

Anderson, J. W., T. J. Hanna, X. Peng and R. J. Kryscio. (2000). Whole grain foods and heart disease risk. *Journal of American College of Nutrition,* 19:291-299.

A.O.A.C. (1995). Official Methods of Analysis. Trends Food Science Technology. *Association of Official Analytical Chemists*, Washington, DC, USA.

Blumenthal, M. A. Goldberg, J. Brinkman. (2000). Herbal Medicine: Expanded Commission E Monographs. Integrative Medicine Communications. *Molecular Nutrition and Food Research*, 49: 560-570.

Elli, M., Cattivelli, D., Soldi, S., Bonatti, M. and Morelli, L. (2008). Evaluation of Prebiotic Potential of Refined Psyllium (*Plantago ovata*) Fiber in Healthy Women. *Journal of Clinical Gastroenterology*, 42: S174-S176.

Fischer, M. H., N. Yu, G. R. Gray, J. Ralph, L. Anderson, and J. A. Marlett. (2004). The gel-forming polysaccharide of psyllium husk (*Plantago ovata Forsk*). *Carbohydrates Research*, 339:2009-2017.

Guo Q, Cui S.W, Wang Q and Young J. C (2008). Fractionation and physico-chemical characterization of psyllium gum. *Carbohydrate Polymers.* 73 (1) : 35-43.

Kamaljit K., K. Amarjeet and S. Tarvinder Pal (2011). Analysis of ingredients, functionality, formulation optimization and shelf-life evaluation of high fibre bread. *American Journal of Food Technology*, 6 (4) : 306-313.

Liangli Yu (2000). Acid and solvent modification of psyllium. Patentee WO1999062342 A9.

Lindsey, W. L. and Norwell, M. A. (1969). A new DPTA-TEA soil test for zinc and iron. *Agron. Abst.*, 61 : 84.

Luccia B. H. D. and Kunkel A. E. (2002). Psyllium reduces relative calcium bioavailability and induces negative changes in bone composition in weanling Wistar rats. *Nutrition Research*, 22: 1027-1040.

Marlett, J. A. and M. H. Fischer (2002). A poorly fermented gel from psyllium seed husk increases excreta moisture and bile acid excretion in rats. *Journal of Nutrition*, 132: 2638-2643.

Prosky L, Asp N, Schweizer T, Devries J, Furda I (1992). Determination of insoluble and soluble dietary fibre in foods and food-products - collaborative study. *Journal of AOAC International*. 75(2) : 360-367.

Rosario D R R, Flores D M (1981). Functional properties of flour types of milling bean flour. *J Food Sci. Agric.* 32 : 175-180.

Singh, B. (2007). Psyllium as therapeutic and drug delivery agent. *International Journal of Pharmaceuticals*, 3 (34): 1-14.

Syed K A, Syed H M, Deshpande H W and Sawate A R (2018). Standardization of acid concentration and solvent ratio for modification of psyllium husk (*Plantago ovata* F.). *International Journal of Chemical Studies*. 6 (2) : 2318-2323.

Xiaoyin Pei (2008). Acid modification of psyllium. Associate Professor, Liangli (Lucy) Yu, Ph.D, Department of Nutrition and Food Science.

Yu L and Perret J (2003). Effects of solid-state enzyme treatments on the water absorbing and gelling properties of psyllium. *LWT Food Science and Technology*. 36 (2) : 203–208.

How to cite this article:

Katke, S. D., H. W. Deshpande, B. S. Agarkar, R. B. Kshirsagar and Gadhe, K. S. 2020. Studies on Effect of Partial Hydrolysis on Functional Properties of Ispaghula Husk. *Int.J.Curr.Microbiol.App.Sci.* 9(11): 3868-3874. doi: https://doi.org/10.20546/ijcmas.2020.911.462