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Critical Analysis of Wheat Bran as Therapeutic Source

Manali Chakraborty[1], Dr Savita Budhwar[2]

[1]PhD Scholar, [2]Assistant Professor

[1,2]Department of Nutrition Biology, Central University of Haryana, Mohindergarh, Haryana, India

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ABSTRACT

Increasing population now-a-days is one of the most crucial phases of upcoming future troubles. Food wastage along with the nutritional expenditure should not be entertained. Several milling by-products of crops viz., wheat bran, are principle pool of nutrients. It is very much essential to study and gain knowledge about the nutrients, anti-oxidants, anti-nutritional components and their effect upon diseased condition along with the probability of production of edible food stuffs for human. Though there is enough production of wheat bran, most of the amount is either wasted or used as livestock fed. It has been shown that bran part has potential efficiency to be used as therapeutic tool for various diseases such as, cancer, obesity and diabetes, bowel irritation etc. Its role as a prebiotic might also prove an asset to remarkably influence gut microflora. Its anti-nutritional content is also lower than the rice bran and that is also manageable for the further use as food stuff. The physicochemical properties along with its nutrient as well as anti-nutrient contents must be utilized and regulated as requirement to combat malnourishment besides hunger issues and therapies.

Keywords: *wheat bran, by-products, nutrient content, physicochemical property, phytic acid*

1. INTRODUCTION

Global population and its subsequent increment is one of the most critical challenges for the future. Additional food demand, malnourished condition would create a terrible concern in the coming timeline of human kind until and unless maintenance of post-harvest losses and food security is considered from now only. It is expected that population mark will rise up to 9.1 billion people by the year 2050 and almost 70% extra food requirement will be needed to avoid hunger issues[1-3]. Though developing countries already started to improve their agricultural condition and productions, awareness regarding post-harvest loss (PHL) is still not sufficient. Less than 5% research funding has been issued in this context in previous few years[4-7]. “Food loss” is defined as food that is available for human consumption but goes unconsumed[8,9]. Not only the post harvest losses are required to come across our concern, agro wastes from milling industries are also come under vital issues. Due to lack of proper knowledge, less research on human consumption, these milling by-products are only used either for animals or a very lesser amount as human fed. Although these are being used for industrial purposes, nutritional importance of these wasted by-products are also matter to be noticed. “Food waste” is described as discarded food or alternatively the intentional non-food use of the food or due to spoilage/expiration of food[10]**.** These wasted by-products, mainly husk, straw, bran or broken parts of many cereals, pulses if processed carefully and efficiently, production of cheap and nutritious foodstuffs might be possible. Most consumed and popular food crops in the World mainly are cereal grains viz., wheat, which are also the foundation of staple foods in most of the budding countries. Maintaining loss of these cereals besides the utilization of every part of these grains could be one of the proficient ways to combat hunger, food demand, malnourish, and rural development. Wheat (*Triticum aestivum)* comprises its bran part (13-19%) that is mainly used for nonfood purposes in spite of having high nutrient significance. Only 10% bran is being used in food industries[11,12] among 45 to 90 million tons worldwide production (FAO 2011). It is highly rich in phytochemicals and minerals along with dietary fiber. Consumption of bran already been linked to reduced risk in cancer, diabetes, cardiovascular diseases due to presence of biochemical compounds entrenched in it[13]**.**

2. Production of wheat and its bran:

Reducing agro losses during industrial processing and to make use of by-products appropriately for human feed is now a major global concern. Before utilizing such wasted parts, their nutrient as well as anti-nutrient breakdown is very much needed to understand for their consumable properties along with toxicities, if any. It is also crucial to gather data about their physiochemical properties that helps in many aspects of food product formation.

Besides rice paddy, wheat is also a primary cereal crop, mainly used for human consumption and domestic animals feed. Among its principle fractions, bran is mostly used. According to GAIN (Global Agricultural Information Network) report (IN7031), marketing year 2017/18 wheat production is 95 MMT from 31.8 million hectare and about 3.0 MT/hectare yield. The major by-product from flour milling i.e. bran is mainly used for animal fed. 90% bran is utilized for this purpose and rest 10% for food products wasting rich nutrients[12].

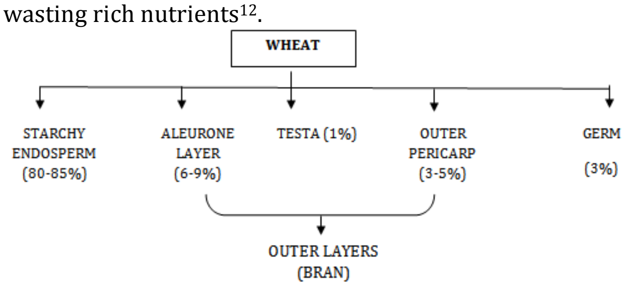

Figure 1: Percentage of wheat grain parts[14]

Micro contents present in wheat bran:
Nutrient analysis as well as anti-nutrient estimation of the agro wastes is very much urgent to know about their delicate properties and also harmful characteristics, if any[15].

Especially the outer layer of wheat grain contains high level of antioxidants, vitamins (vit-E, B), phenolic compounds, sterols, minerals, insoluble dietary fibers. Its nutritional composition also includes bioactive compounds viz. alkyl rescorcinols, ferulic acid, flavonoids, carotenoids, lignans, also called phytochemicals[11, 13, 16]. Phenolic acids in bran part remain in bound and free, both states with approximately 99% of ferulic acid in insoluble and bound situation[17].

Table 1: Nutritional breakdown of wheat bran:

Major components of bran portion[17]	
Bran component	**Range % dm**
Dietary fiber	33.4-63.0
Moisture	8.1-12.7
Ash	3.9-8.10
Protein	9.60-18.6
Total carbohydrate	60.0-75.0
Starch	9.10-38.9
Phytochemicals	**µg g-1**
Alkylrescorcinol	489-1429
Phytosterols	344-2050
Ferulic acid	1376-1918
Bound phenolic compound	4.73-2020
Flavonoids	3000-4300
Micronutrients	**Mg per 100 g**
Phosphorus	900-1500
Magnesium	530-1030
Zinc	8.3-14.0
Iron	1.9-34.0
Manganese	0.9-10.1
Vitamin E (Tocopherols/ tocotrienol)	0.13-9.5
Vitamin B	
Thiamin (B1)	0.51-1.6
Riboflavin (B2)	0.20-0.80
Pyridoxine (B6)	0.30-1.30
Folate (B9)	0.088-0.80
Other essential components in wheat bran[18]	
Components	g/100g wheat bran
a) Non-starch polysaccharide	
Glucan	10.5
Xylan	18.3
Arabinan	10.1
Galactan	1.1
b) Starch	34.0
c) Klason lignin	5.0
d) Crude protein	13.5

Antioxidants in bran		
Antioxidant	**Concentration (µg/100 g)**	**Reference**
Lignans		
lignan aglycones	2774	19
Syringaresinol	1953	
Isolariciresinol	297	
Lariciresinol	257	
Secoisolariciresinol	142	
pinoresinol	106	
matairesinol	9.4	
Carotenoids	0.68	20
Lutein	1.8	
Zeaxanthin	0.54–27	
Tocopherols		
α tocopherols,	1.28–21.29	21
δ tocopherols,	0.23–7.0	
γ tocopherols,	0.92–6.90	

Note: Dm, dry matter.

Due to presence of these potential components in wheat bran it could be beneficial to lower blood cholesterol level, cardiovascular diseases, type II diabetes, cancer prevention and many others[18,22]

Table 2: Presence of nutrition in various part of wheat bran layers:

Wheat bran layer	Nutrient	Reference
The pericarp	Insoluble dietry fiber Ferulic acid Bioactive compounds Vitamins	23
Aleurone layer	Minerals Vitamin B Protein Lignans Bioactive compounds Antioxidant Phytate Phenolic acids	24-29
Testa tissue	Alkylrescorcinols	30

High amount of starch as well as nitrogen content in wheat bran in comparison to that of rice, it can be used as an inducer for the production of various enzymes viz., CMCase, amylase, phytase etc[31-34].

Besides, wheat bran is been used for several metabolite production such as Bacitracin by *Bacillus licheniformis* along with soya bean in 1 : 3[35].

Table 3: list of enzymes, present in wheat bran:

Enzymes	Producer microorganism	Enzyme activity	Reference
Proteases			
	Aspergillus sp. and Mucor pusilus	--	36
Acid Protease	Aspergillus oryzae	--	37,38
Neutral metallo protease	Aspergillus oryzae NRRL 2217	--	39
Acidic	Aspergillus oryzae MTCC 5431	8.26 × 105 U/g cell mass	34
Alkaline	Thermoactinomyces thalophillus PEE14	1620 U/g cell mass	40
α- amylase			
	Bacillus licheniformis	--	41
	Bacillus cereus MTCC 1305	122 U/g cell mass	42
	Aspergillus niger	_	43
	Apergillus awamori: Nakzawa MTCC 6652	9420 U/g cell mass	44

Lipase			
	Aspergillus niger	4.8 IU/ml	45
	Bacillus megatarium AKG1	--	46
	Alkalophilic Yeast		47
Pectinase			
	Streptomyces lydicus	--	48
	Bacillus sp. DT7	8050 IU/g cell mass	49
	Aspergillus niger	36.3 IU/g cell mass	50
	Penicillium veridicaltum RFC3	100 IU/ml	51
	Aspergillus foetidus NRRL 341	1860 IU/g cell mass	52
Glucoamylase			
	Aspergillus HA-2	264 U/g cell mass	53
	Aspergillus sp.	454 U/g cell mass	54
	Aspergillus oryzae	1986 U/g cell mass	55
Xylanase			
	Aspergillus niger	33%	56
	Trichoderma longibrachiatum	592.7 U/g cell mass	57
	Bacillus sp. AR009	720 U/g cell mass	58
	Bacillus licheniformis A99	1.63 U/g cell mass	59
	Aspergillus niger XY-1	14637 U/g cell mass	60
	Staphylococcus sp. SG-13	4525 U/l	61
Cellulase			
	Trichoderma reesei RUT C30	--	62
	T. viride CMGB	3.18 FPU/ml	63
Tannase			
	Paecilomyces variotii	--	64
	Aspergillus aculeatus DBF9	8.4 U/g cell mass	65

Table 4: effects of fermentation on the antinutritional factors (tannins and phytic acid)[66]

wheat bran	Tannin (mg catechin/ 100 gm material)	Phytic acid (mg/100g)
non-fermented		
Coarse	0.03^{d}	626.12^{c}
Medium	0.06^{b}	740.36^{b}
Fine	0.07^{a}	795.20^{a}
Fermented		
Coarse	0.01^{e}	572.79^{d}
Medium	0.05^{c}	367.13^{e}
Fine	0.06^{b}	301.63^{f}

3. Physicochemical properties of bran:

In a study the particle size was reduced to 90 µm from 1200 µm along with hydrothermal (wet steeping in acetate buffer at pH 4.8 at 55 °C for 60 min) and fermentation (using bakery yeast for 8 h at 30 °C) to note down the effect of these combined treatments upon few properties of bran with a goal to reduce phytic acid content, an anti-nutrient, of the bran. Though Hydrothermal and fermentation decreased, particle size reduction on its own or in combination increased bran lightness. Decrease in swelling power along with water solubility and water holding capacity was observed with reduction in particle size. Although Swelling power and water holding capacity of the hydrothermaled and fermented bran were lesser, in reverse, water solubility was elevated than the control. The amount of Fe^{+2}, Zn^{+2} and Ca^{+2} were also become less when the particle size was reduced. Interestingly fermentation had no hit upon $Fe^{+2}$and Zn^{+2} but somewhat reduced Ca^{+2} were recorded. The hydrothermal behavior to some extent lowered these elements' level. Hydrothermal treatment by the side of particle size reduction showed the lowest phytic acid and maximum fiber content[67]**.** Physiological effects of insoluble dietary fibers are also been get influenced due to the physicochemical properties during consumption. Thus it points out that these properties should be customized to get better the fibers' physiological properties. Treatment with microfluidization process of the bran was done to analyze effects on physicochemical properties. This treatment showed that this process could successfully reduce particle size and bulk density, and significantly enlarge specific surface area, water-holding capacity, swelling capacity, oil-holding capacity and cation-exchange capacity. These nutritionally related changes may boost the physiological properties of bran[68,69]. To increase the value of wheat bran further than livestock feed needs an ample set of methodical tools. This review gives an outline over the breakdown of wheat bran constituents in general and dietary fiber in particular with a spotlight on instrumental techniques. Gas chromatography, liquid chromatography, capillary electrophoresis, thin layer chromatography, size-exclusion chromatography, field-flow fractionation, nuclear magnetic resonance spectroscopy and infrared along with near-infrared spectroscopy are accessible for dietary fiber analysis[70].

Table 5: Sources of wheat bran as human fed[71]:

Product	Fibre per 100 g AOAC	Standard portion size (g)	Fiber per portion (g)
Bran shreds breakfast cereal	27	40	10.8
Bran flakes breakfast cereal;	15	30	4.5
Shredded wheat breakfast cereal	11.8	45	5.3
Extruded pillos breakfast cereal	9.9	45	4.5
Whole wheat biscuits breakfast cereal	10	37.5	3.8
Wholemeal bread	7362.5		
Granary bread	5.3	36	1.9
Brown bread	5361.8		
Sliced white bread	2.5	36	0.9
Dried whole meal pasta (uncooked weight) 9	44	4.0	--------
Dried wholemeal pasta (uncooked weight) 9	87	7.8	--------
Dried wholemeal pasta (uncooked weight) 9	130	11.7	--------
Dried white pasta (uncooked weight)	2.8	75	2.1
White pasta (cooked weight)	1.2	180	2.2
Wheat couscous (dry weight)	5603.0	------	------

Note: Compiled from Manufacturer's websites 2011.

4. Wheat bran and diseases:

Wheat bran plays a key role in case of bowel cancer. According to the European Prospective Investigation into Cancer and Nutrition (EPIC)[72] people who take low fiber diet can appreciably lessen risk of colorectal cancer, by 40%, due to intake of more fiber-rich foods. Likewise, the World Cancer Research Fund's report on cancer and diet, physical activity and weight recommended that foods containing fiber decline risk of colorectal cancer (WCRF/AICR 2007). In addition, animal studies have also confirmed a noteworthy defensive outcome of wheat bran on colon carcinogenesis in rats fed a high-fat western-style diet[73]. Wheat bran, together with psyllium (50:50), resulted in enhanced shield and synergistic effects may hold back various phases of the carcinogenic process, besides wheat bran phytic acid slow down earlier stages and psyllium restrain later stages[74]. Colon cancer is not the only cancer which is linked to fiber. A notable shielding effect of fibre also observed in breast cancer research. According to[75] in pre-menopausal women, total fiber acts like shield against breast cancer, in particular fiber from cereals and possibly fruit.

Cardiovascular diseases also get benefit from whole grains when it contains considerable amount of fiber or bran. A major effect on CVD had been noticed leading to reduction in level of serum cholesterol. Consumption of a wheat bran-based breakfast cereal for 3 weeks, containing roughly 13.5 g of fiber, serum cholesterol was dropped down from 5.576 to 4.385 mmol/l in those participants with the highest quintile of serum cholesterol according to a study done by[76] Costabile et al. Besides, no decline was noted in beneficial HDL-C, signifying beneficial effects on CVD risk. Carlson et al.[77] found that increasing dietary fibre was associated with lower risk of metabolic syndrome coronary heart disease (CHD).

Data from epidemiological studies confirms a contrary connection between ingestion of dietary fiber and weight gain and obesity, while fiber utilization is allied with enhanced satiety and less energy intake[78]**.** Along with these it is also recorded that dietary fiber amplifies faecal energy loss[79]**.** The consequence of wheat bran on postprandial appetite regulating hormones is not that much well studied, though a recent animal study[80] found out the effect of wheat bran on GLP-1 secretion, and no effect on body weight, adipose tissue mass, glucose or insulin resistance was observed. On the other hand, this work displayed a hit of wheat bran on inflammation, together with decreased inflammatory cytokines.

McIntyre et al. [81] showed wheat bran has an effect on faecal bulking along with delayed gastric emptying and accelerated small bowel transfer. Dietary intake may modify the gut flora components such as having prebiotic. Prebiotics are as non-digestible food ingredients that constructively have an effect on host health by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon[82]**.** Prebiotic contents of dietary fiber in wheat bran (including beta-glucans) due to fermentation by colonic microflora form SCFA, which results in physiological changes to the colonic contents, leading to change in bulking, water retention capacity and viscosity. Costabile et al.[76] found a more unassuming alter in gut microflora after having a wheat bran cereal, rather than a whole grain cereal. Markers of colonic metabolic output (including ferulic acid and SCFAs) also get more than before.

5. Conclusion:

Each year a large amount of wheat bran are wasted in spite of possessing significant nutritional quality. Though bran is used for livestock fed, biodegradable material packaging and as human fed in some extent, it has not been that much utilized due to lack of analytical tools and techniques. More detailed studies and project plan should be proposed to beneficially use up the bran to slow down the nutritional wastage.

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