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Anthocyanin Biofortified Coloured Wheat

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ARTICLE ID: 92

Introduction

Among the most extensively grown and consumed crops in the world; wheat is the one that stands out. It is because this is the primary ingredient in the daily food consumed by more than one-third of the global population. As the mind-set of the population is transforming from consumption of food for energy to seeking more nutrition out of their diet, the consumers are looking for healthier alternatives that are available more commonly than their counterparts. However, most of these alternatives are pricey which makes them difficult to include in the daily diet. As a solution to this problem, the National Agri-Food biotechnology Institute Mohali has developed wheat that has supplemental anthocyanin content, aka coloured wheat. In the recent past, such coloured wheat varieties that are rich in different phytochemicals and anthocyanin are gaining customer attention due to them being cheaply available all over the world, coupled with their additional health benefits. Some commonly known health benefits of the anthocyanin in such coloured wheat are protection from like hypertension, dyslipidaemia, and diabetes.

Images of (a) blue wheat (b) black wheat (c) purple wheat

Different forms of coloured wheat:

The positioning and types of anthocyanins in wheat layers determines the colour form of the coloured wheat, which are available in three colour forms: blue, purple, and black.

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- **Purple wheat:** The purple colour is due to a mutation in the pericarp as the pericarp layer contains the anthocyanin.
- **Blue wheat:** The blue colour in this wheat is due to wide introgression. The aleurone layer is site of localization of this pigment.
- **Black wheat:** Because purple and blue wheat were crossed to create this variety of wheat, it contains features of the two i.e. anthocyanin in the pericarp and in aleurone layer as well.

Nutritional components of coloured wheat:

As demonstrated in Table 1, coloured wheat contains abundant amount of macro and micro-nutrients like proteins, lipids, carbohydrates, minerals and vitamins; anthocyanins; phytochemicals; total dietary fibre; and numerous bioactive substances.

- **Macronutrients**: It was discovered that coloured wheat had greater levels of essential amino acids, total amino acids, and protein content, when compared to common wheat by 7.31 - 18.13%, 8.88- 18.91%, 11.74 - 18.17%, respectively.
- **Micronutrients:** Higher amount of nutrients including zinc, selenium, magnesium, phosphorus, potassium and iron were identified in coloured wheat. It also contains a small concentration of vitamin K, vitamin D and provitamin A; while also being rich in vitamin E, and vitamin B like riboflavin, niacin, pyridoxine, folate, thiamine etc.
- **Anthocyanins:** Different coloured wheat contains different forms of anthocyanins. These all are derivatives of phenolic or sugar groups of six primary anthocyanidins, namely petunidin, peonidin, malvidin, delphinidin, pelargonidin, and cyanidin. Blue coloured wheat contains 22 types of anthocyanins with concentration of 80 ppm, purple wheat contains 23 types of anthocyanins with 40 ppm concentration, and black wheat contains 26 types with 140 ppm concentration.

Table 1: Nutritional composition of coloured wheat

	Forms of coloured wheat		
	Purple	**Blue**	**Black**
Protein (%)	10.3-19.3	12.3-15	11-12.9
Total Dietary Fibre (%)	9.8-15.1	12.7-13.5	13-13.3
Fat (%)	1.21	1.2	1.7
Starch (%)	48.7-59.9	12.3-15	-

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Magnesium	-	430	450
Calcium	419.6	310	184
Iron	36.7-46	38.3-46.1	39-79.3
Manganese	15-40.1	14.8-40.9	12.7
Copper	4.1-6.9	6.0-9.6	3.17
Zinc	25-41.7	33.1-40	28-80
Total anthocyanin content (mg/kg)	12.8-172	68-211	128-198
Total phenolic content (g/kg)	6.26	6.8	0.659.8
Total flavonoid content (mg/100g)	21.6-102.9	-	31.9

Source: Saini et al. (2021)

Bioactive compounds:

Coloured wheat is reported to have higher bound phenolic acid content than free phenolic acids resulting in increased antioxidant activity. It is rich in protocatechuic, vanillic, gallic, syringic, p-coumaric, ferulic, isoferulic, salicylic acids.

Health benefits of coloured wheat

- Pigmented wheat can help fight infections prompted by free radicals, owing to its high antioxidant capacity.
- Black wheat is found to have obesity controlling capacity.
- Coloured wheat has high carbohydrate and fibre content and lower sugar level, making it an ideal diet for those with diabetes.
- High anthocyanin content helps in maintaining antibodies and hindering production of free radicals.
- Coloured wheat is heart friendly because of its unsaturated fatty acids.
- It helps in weight reduction as cravings are reduced because coloured wheat keeps full.
- Gut health is maintained while averting constipation because of its high fibre content.

Commercial use of coloured wheat:

Coloured wheat has high tensile strength that makes it ideal for bakery industry. These bakery goods' shelf lives are extended by anthocyanin, which also help resist against moulds. Wheat lines with varied colours can be used to produce a variety of functional foods and have a better nutritional content. Hence, coloured wheat has every quality necessary for commercial usage.

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Impact of food processing on phytochemicals in coloured wheat:

According to most of the studies, anthocyanin content falls during the processes of cooking like fermentation and baking, while the antioxidant activity increases or decreases relatively less. The potential explanation is that heating causes anthocyanins and phenolic compounds to break down, and these breakdown products may have more antioxidant potential than their colourful original forms. Alternatively, it may also be a consequence of the synergistic effects of several phytochemicals. But additional study is needed to determine how food processing affects the nutritional content of the processed coloured wheat products.

Disadvantages:

A major disadvantage of coloured wheat is its lower yield as compared to normal wheat. Normal wheat yield is around 24 quintals per acre while coloured wheat is around 17-20 quintals. The development of coloured wheat faces this significant obstacle. It is as a consequence of linkage drag related to blue wheat aleurone layer; imparted by wild wheat appearing as substitution, translocation and addition lines.

Conclusion:

Coloured wheat has higher antioxidant activity along with greater protein grouping, fundamental amino acids and it contains additional nutrients that includes magnesium, iron, and zinc than regular wheat which makes it superior for use as health supplement and fighting malnutrition. Food products derived from such pigmented wheat have anti- inflammatory and antimicrobial activity due to presence of bioactive phytochemicals that helps to regulate weight, cholesterol and glucose levels.

References

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