

QUALITY OF INDIAN WHEAT

The native Indian wheat had been globally recognized for its quality and was always in demand from overseas clients. During later half of the 19th century, several Indian wheat varieties were used as parental lines in many other countries for improving the grain quality. Between 1888 and 1910, India was in fact exporting wheat to a large number of countries. The sudden surge in population and two world wars saw India becoming a food grain deficit nation. The low input, traditional agriculture, local tall wheat varieties, inadequate irrigation facilities and the overall stagnant rural economy restricted wheat production at a very low level up to 1965. By 1970, because of the impact of the green revolution, many visionaries predicted that India will not only become self-sufficient but will also build adequate buffer to thwart adverse weather and other calamities. This has come true and India has made great progress in wheat research and development.

India achieved record production of 95.91 million tons during 2013-14 (fourth estimate) and is the second largest producer of wheat in the world. The production is >90 million tons for last few years inspite of several unforeseen adversities. It shows the resilient nature of Indian wheat programme and this could be made possible by developing high yielding, disease resistance varieties and matching production technologies. Wheat is a unique gift of nature to mankind as a large number of end-use products such as chapati, bread, biscuit and pasta etc. can be made from it. The increase in domestic demand of baked and pasta products along with economic liberalizations and global trade have offered opportunities for better utilization of wheat. The growing demands for convenience foods such as ready- to- eat, frozen, microwavable and instant products has promoted the increase in mechanized food production in larger commercial plants and the increase in wheat products sold in the supermarkets. The annual growth rate of the baking industry is projected to be around 5 - 7% (Table 1). Hence, wheat quality needs uppermost attention so as to meet the domestic and export requirements in the time to come.

Table 1: Production of Various Wheat Products (Lakh tons) in India

Year	Bread	Biscuit	Pasta
1991	9.4	12	0.8
1996	11.8	15.8	1.1
2001	14.9	19.8	1.4
2012	26.6	35.3	2.5

Industrial Quality requirements of Wheat Products

Three species of wheat namely, *T.aestivum*, *T.durum* and *T.dicoccum* are cultivated in the country. Bread wheat is contributing approximately 95 % while around 4% comes from durum wheat and just about 1% is the share of dicoccum wheat to the total wheat production. The quality requirements of wheat for various products like chapati, bread, biscuit and pasta are different (Table 2). Hard wheat (*T.aestivum*) with strong & extensible gluten and high protein is required for making good bread. For biscuit, the quality requirements are soft wheat, low protein and weak & extensible gluten for chapati, we need hard wheat, medium to high protein and medium & extensible gluten. For pasta products, hard wheat (*T.durum*) with strong gluten, high protein, low yellow berry incidence and high yellow pigment (β -carotene) content are required.

Thus grain hardness, protein content & its quality and gluten strength are the main processing quality parameters.

Table 2: Industrial quality requirements of wheat products

	Grain texture	Protein content	Gluten Strength	Starch
Bread wheat				
1. Chapati	Hard	10-13%	Medium, extensible	----
2. Biscuit, Cakes	Soft/ Very Soft	8-10%	Weak, extensible	----
3. Bread	Hard	>13%	Strong, extensible	Partial Waxy
4. White Noodle	Soft	10-12	Medium	Partial Waxy
5. Yellow Noodle	Medium	10-13	Medium	Partial Waxy
Durum wheat				
Pasta products	Hard	>13%	Strong	Partial Waxy

Other important traits: High semolina yield & yellow pigment (Beta carotene) content in durum wheat and high extraction rate in bread wheat.

Promising Varieties for various Wheat Products

In view of the above, it is necessary to identify (from the ongoing programme) & develop product specific varieties for various industrial purposes. Based on the analysis of AICW&BIP trials, product specific varieties have been identified (Table 3) for chapati (>8.0 score out of 10.0), bread (>575 ml loaf volume), biscuit (>11.0 spread factor) and pasta (>7.0 score out of 9.0). The chapati quality in India is among the best in the world but we need improvement in bread & biscuit quality. Attempts are in progress to develop such promising varieties by targeted quality breeding programme and advance lines are being tested in the national coordinated programme.

Table 3: Promising Varieties for various Wheat Products

Chapati (>8.0/10.0)	C 306, Raj 3765, HD 2864, HD 2285, PBW 226, PBW 175, PBW 373 (NWPZ), C 306, K 0307, K 8027, K 9107, MACS 6145, UP 262, NW 1014, HUW 234, HD 2888, HUW 533 (NEPZ), LOK 1, C 306, Sujata, HI 1500, HI 1531, HI 1563, HW 2004, DL-788-2, GW 173, GW 273, GW 322, Raj 4238, Raj 3077 (CZ), LOK 1, HD 2987, HD 2833, GW 496, MP 3336, NIAW 34, NIAW 1415 (PZ).
Bread (>575 ml loaf volume)	WH 1021, WH 1080, NW 2036 (NHZ), HD 2285, PBW 396 (NWPZ), HD 277, HD 2733, NW 2036 (NEPZ), Lok 1, HD 2864, HD 2932, GW 120, GW 173, GW 190, GW 496 (CZ), HI 977, Raj 4083, HD 2189, HD 2501, HD 2781, DWR 162, DWR 195, MACS 6222, MACS 6273, MACS 2496, UAS 304, AKAW 4627, NIAW 34, NIAW 1415, NIAW 917, NI 5439 (PZ).

Biscuit (>11.0 spread factor)	HS 490 (NHZ).
Pasta (>7.0/9.0)	PDW 233, WH 896, WHD 943, PDW 291, PDW 314 (NWPZ), HI 8627, HI 8663, HI 8498, HI 8713, HD 4672 (CZ), MACS 2846, DDK 1009, NP 200, HI 8663 (PZ).
Extraction rate (>70%)	C 306, PBW 175, WH 1021, WH 1080, DPW 621-50, HD 2967 (NWPZ), HD 2733, HD 2888, K 0307, K 9107, K 8027, HUW 234, C 306 (NEPZ), Lok 1, GW 322, DL 788-2, MP 4010 HI 1500, HI 1544, MP 3288, (CZ), MACS 6222, HD 2189, Raj 4083, HI 977, HD 2781, NI 5439, NIAW 1415 (PZ).

The issues involved in the improvement of industrial quality are, (i) critical evaluation of germplasm (both indigenous and exotic) for important quality parameters along with their genetic and molecular characterization for the identification of promising parents, (ii) development of product specific wheat varieties involving identified promising parents & using summer nursery facilities at Lahaul Spiti / Wellington, (iii) development of micro-level tests requiring small amount of wheat and less analysis time so as to use them in analysing early generation breeding material, (iv) establishing relationship of end products with different yield and quality components, (v) use of molecular marker technology approaches for the improvement of wheat quality and (vi) studies on starch and other components to enhance wheat quality.

Nutritional Quality

Minerals although required in very small amounts are very important part of the metabolism. For populations which are mainly dependent on cereal based diets or live in the regions where the soils are low in minerals, often suffer from malnutrition. Nearly 2 billion people around the world are affected by micronutrient deficiency according to the World Health Organisation.

Table 4: Promising Wheat Varieties for the Nutritional Quality Parameters

Parameter	Value	Genotypes
Bread wheat		
Protein	>13.0%	MACS 6222, NI 5439, MP 3382, HD2932, Raj 4083, NIAW 1415, HW 5216
Yellow Pigment	>4.0 ppm	VL 907, VL 804, HS 490, DBW 39, PBW 373, NW 2036, COW (W) 1
Iron	>45.0 ppm	K 8027, HD 2888, MP 3288, NIAW 1415, NI 5439, COW (W) 1, HW 2044, HI 1500, HW 5216
Zinc	>40.0 ppm	HW 2044, HI 1500, HW 5216, COW (W) 1
Durum wheat		
Protein	>13.0%	A-9-30-1, UAS 428
Yellow Pigment	>4.0 ppm	PDW 233, HI 8627, NIDW 295
Iron	>45.0 ppm	A-9-30-1, HI 8627
Zinc	>40.0 ppm	A-9-30-1, AKDW 2997-16

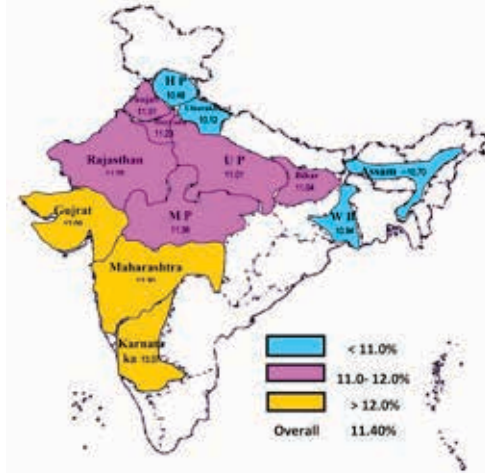
Based on the analysis of AICW&BIP trials, specific varieties have been identified (Table 4) for protein content (>13.0%), yellow pigment (>4.0 ppm for *T. aestivum*

and >6.0 ppm for *T. durum*), iron content (>45.0 ppm) and zinc content (>40.0 ppm). There is further need to enhance the bioavailable concentrations of these elements in wheat. Wheat is also a good source of a number of phytochemicals, which are beneficial to health and contribute to the antioxidant capacity of wheat. These include carotenoids, phenolics, lignins, vitamins, minerals and phytates. These antioxidants can provide additional health benefits and can help in controlling the aging related diseases like heart diseases, cancer, diabetes and other degenerative diseases. Out of different grain fractions, bran has the highest antioxidant activity followed by whole meal and flour. Therefore, for better health benefits, the food products based on whole grains are recommended.

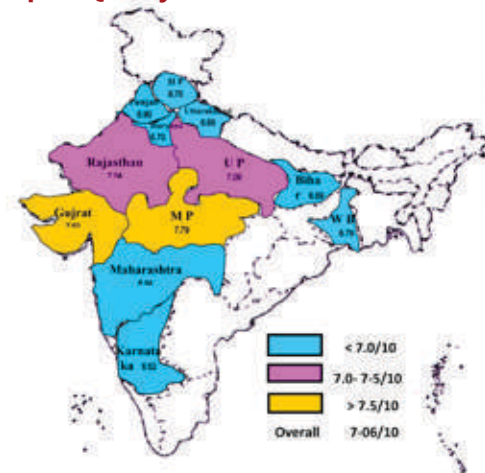
Analysis of Wheat Samples from Mandis/Farmers' Fields

More than six thousand wheat samples, collected from main mandis of 13 major wheat growing states, have been analysed for grading & non grading parameters, flour characteristic, HMWGS, rheological properties and baking evaluation of chapati, bread & biscuit. Atlas have been prepared for all the quality parameters, product specific varieties and areas have been identified. This would help in making strategies for procuring wheat from the mandis for domestic and export purposes. The situation is satisfactory with regard to the test weight but the mandi samples need improvement in damaged kernel, foreign

Protein Content in Different States of India



Chapati Quality in Different States of India



matter, shrunken and broken kernel. Through proper cleaning and grading by machines, samples in lower grades can be upgraded to higher grades. The average protein content is relatively low in the northern parts of the country (10-11.5%) and it improves in the central and peninsular region where it remains between 12-13%. Average extraction rate is maximum in Madhya Pradesh (70.7%). The baking data clearly indicated that the upper part of the country comprising of Himachal Pradesh, Uttranchal and Punjab is comparatively better in biscuit quality. The middle part of the country particularly Madhya Pradesh, Rajasthan and Gujarat is good in chapati quality. Likewise, the lower part of the country comprising Gujarat, Maharashtra and Karnataka is comparatively better for bread quality and bread loaf volume.

Analysis of FCI Wheat Grain Samples for Wheat Export

Out of a total of about 600 million tones world wheat production, around 150 million tones wheat is traded and it is dominated by USA, Australia, Canada & Argentina, which account for about 75% of the total exports. The major importers are Iran, Brazil, Japan Algeria, Egypt, European Union, Indonesia, South Korea, Morocco and Philippines etc. Indian share in global export is very less and also inconsistent. Wheat is traded the world over based on classes and grades. The class refers to the functional quality of wheat associated with the product specificity for example chapatti, bread, biscuit, pasta, noodle etc. whereas the grade refers to the physical quality of wheat. Based on the clients need, the assorted grain classes are made available and the exact price is dependent on the market forces and the physical purity (grade) of the consignment. There is a need to classify and grade the Indian wheat, as well.

Considering the production levels of 93.51 million tons during the year 2012-13 and estimated production of 95.91 million tons during 2013-14, India can emerge as a major player for wheat export. Five thousand five hundred fifty five (5555) wheat grain samples during 2012-13 and two thousand two hundred and twenty two (2222) during 2013-14 drawn from stocks of Food Corporation of India (FCI) covering three states viz. Punjab, Haryana and Madhya Pradesh were analysed for various physical or wheat grading parameters like test weight, damaged kernel, foreign matter, shrunken & broken kernel, total defects & other classes and wheat functional parameters like protein, moisture, wet gluten, and falling number. Based on these quality data, Food Corporation of India could export about 4.5 million tons of wheat during 2012-13 and about 2.0 million tons during 2013-14 through its exporting agencies. The countries to which wheat has exported are South Korea, UAE, Yeman, Oman, Quarter, Bangladesh, Thailand, Indonesia, Soudi Arabia, Malaysia, Tanzania, Ethiopia, Phillipines, South Africa, Sudan, Vietnam etc. The wheat from India has been exported both from West Coast i.e. Mundra, Kandla, Pipavav, Mormugoa, New Mangalore, and East Coast i.e. Krishnapatnam, Grangavaram, Kakinada, Vizag, Chennai and Karaikal. The issues that need consideration to promote wheat export include establishment of an export oriented Govt. Organization on the lines of 'Wheat Board' in Australia; up-gradation of quality related facilities at mandis; segregated procurement, transportation & storage in modern silos; market intelligence; quality pricing policy and adequate linkages between research & industry.

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