A Study to Collate the Physical Parameters and Gluten Content of three Different Wheat Cultivars

Abhilasha Sharma[1], Akansha Ghosh[1], Vandana Arya[1]*, Prabhjot Kaur Sabharwal[1] and Para Dholakia[1]

ABSTRACT

Wheat, other than being one of the main cereal crops of India is also a staple food for majority of Indians, owing to its versatility and adaptability. 29.8 million hectares of area is being cultivated under wheat in India. The wide distribution and production are challenged by infestation losses. To counter this, three new disease resistant cultivars with higher yields were developed by IARI Pusa, namely HD-2967, HD-3086 and HD-3226 and these cultivars were claimed to have a protein content higher than most of the varieties developed before. The aim of present study was to draw a comparison between the physical properties and the quantity of wet and dry gluten present in the above-mentioned cultivars. Analysis of appearance, dimensions and soundness was carried out to compare the physical characteristics. Estimation of gluten content was performed by wash and dry method of gluten isolation. Significant variations were observed in the gluten content and physiochemical properties of the three cultivars

Keywords: *Wheat cultivars, Gluten content, Physical parameters, density*

1. Introduction

Cereals are members of Gramineae family of monocotyledonous. There are eight types of cereals known till now (Kent and Evers, 1994). Cereals are a rich source of carbohydrates and should constitute more than 50% portion of our diet. Wheat being one amongst these eight cereals, has a major consumption and production rate worldwide (Imran et al, 2013). It is a rabi crop and can be best grown in heavy loamy and clay soil (Kent and Evers, 1994). Wheat is generally classified on the basis of the quantity of protein present and the pattern of endosperm fragmentation during milling (Shakuntala and Shadaksharaswamy, 2008).The fragmentation pattern is dependent upon texture of endosperm. The wheat varieties are characterised as follows.

Vitreousness of wheat is highly correlated with high protein content whereas mealiness is correlated with high flour yielding capacity (Glenn, 1991) (Serna-Saldivar, 2010). Vitreous wheat kernels in contrast to mealy kernels, which give an opaque and dark appearance against light, appear translucent and bright against strong light (Kent and Evers, 1994). Mealy grains are soft and weak whereas vitreous grains are hard and strong (Glenn, 1991), (Kent and Evers, 1994). The milling characteristics of the kernels are determined by the way endosperm fractures andis classified into two categories, namely hard or soft wheat (Shakuntala and Shadakshara swamy, 2008). In hard wheat, breakage takes place along the cell boundaries which gives an idea about the pattern areas of mechanical strength whereas in soft wheat the pattern of endosperm breakage is random (Shakuntala and Shadaksharaswamy, 2008).

Strong wheat flours yield bread of high loaf, good crumb texture which has a high shelf-life and are

1 *Department of Food Technology, Shaheed Rajguru College of Applied Sciences for Women, University of Delhi*
* *Corresponding Author* ✉ *vandana.arya@rajguru.du.ac.in*

used to manufacture breads whereas weak wheat flours are used to produce biscuits and cookies as they yield a small loaf with open crumb texture bread (Serna-Saldivar, 2010). These characteristics relate to the protein content of the flour, as strong wheat flour has high protein percentage in comparison to soft wheat, hence strong wheat will have higher gluten content than that of soft wheat cultivars (Kent and Evers, 1994).

Wheat Gluten is an insoluble protein, an elastic and stretchy substance, formed by the interaction between two proteins, gliadin and glutenin, when water and mechanical stress is imparted to the flour which are responsible for hydration of proteins and formation of cross links or cross bonds between the proteins respectively (Biesiekierski, 2017; Cuq, 2000). Glutenin has cysteine residues which is responsible for extending extensibility to the dough whereas gliadin provides elasticity (Biesiekierski, 2017). A good quality gluten will have gliadin and glutenin in ratio of 1:1. (Cuq, 2000) Estimation of gluten content is essential to determine the use of flour. Flour with high protein content is used to make bread and the low protein content flour is used to make cakes, biscuits, and pastries (Kumar et al., 2013).

The initiation of wheat breeding to produce new wheat cultivars with the desired qualities and characteristics, well suited to the changing edaphic factors and the ever-growing demands, took place at the Imperial Agricultural Research Institute, Pusa, in the year 1905. Since then, the development of new wheat cultivars has been a continuous process. This research was conducted on three recently developed wheat cultivars, namely HD – 2967, HD –3086 and HD – 3226. The wheat cultivars were procured from IARI, Pusa. HD – 2967 (2011-12) and HD – 3086 (2013-14) were developed to combat and increase the resistance to diseases such as stripe rust, leaf rust, leaf blunt, Karnal bunt and powdery mildew, Additional resistance against two most virulent races of yellow rust, 78S84 and 46S119 was shown by HD 2967. (Chakrabarti, 2011). After some time, both the wheat cultivars, HD – 2967 and HD – 3086became susceptible to yellow rust and brown rust respectively which ultimately paved the way for the development of HD – 3226, which is not only resistant to fungal diseases such as powdery mildew, foot rot and flag smut but also shows high resistance to Karnal bunt, yellow rust, brown rust and black rust. (Yadav, 2019). HD – 3226 has the highest protein content (12.8%) and gluten content (30.85%) as compared to all the wheat cultivars of present time. It has the highest genetic yield potential of 79.60 q/ha and an average yield of 57.5q/ha. (Yadav, 2019).

2. Methodology

The cultivars have been tested for their gluten content and other physical parameters such as color, size and shape, 1000 kernel weight, bulk density, and hectolitre weight (Nelson, 1980;

Figure 1: Wheat flour dough

Figure 2 : Washing of dough under running water

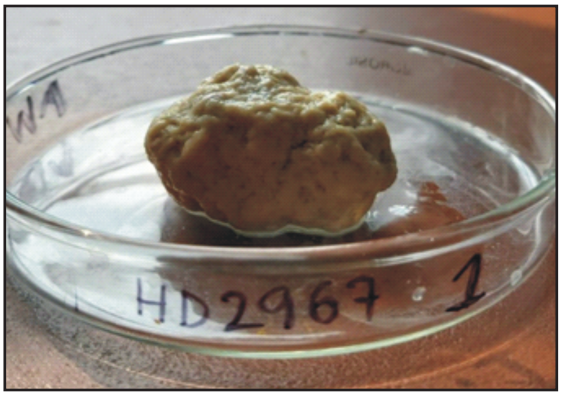

Figure 3 : Wet Gluten

Chung, 1971). Each parameter has its own significance. During estimation all the readings were average of the triplicates.

The estimation of gluten content was carried out by AACC method (AACC International) which is to determine the wet and dry gluten content of the cultivars. The wheat cultivar with highest gluten percentage was considered superior to the others (Balamurugan, 2018). In the stated method, flour of known that is 50g was taken and kneaded to get a soft dough ball shown in fig 1. The dough ball is hydrated by immersing in water for at least an hour so as to strengthen the gluten networks, after this the dough ball is washed under running water to eliminate starch until an elastic mass is obtained (fig 2), (Kaushik, 2014). Elastic ball is then squeezed, and excess of water is hence removed. The ball is weighed and is reported as wet gluten percentage (fig 3). It is then kept at 235-degree Celsius for 15 minutes. The inflated gluten ball is then pierced and dried at 100-degree Celsius for 12 hours and the weight is reported as dry gluten percentage of the flour as shown in *fig 4*.

The physical parameters hold a great significance in comparing and analyzing wheat cultivars (Naik, 2010).

Following are the ways to draw a comparison between the wheat cultivars based on their physical characteristics.

- The kernel's color ranges from light brown to red and is mainly dependent on the genetic character. The grain color is noticed under bright light.
- The size and shape are also an indicator of quality and consumer preference. Longer and slender the kernels, better the appearance and consumer preference. The maximum flour yield is dependent upon the endosperm content which in turn depends on the size, shape, and thickness of bran. Vernier caliper and screw gauge were used to determine length and breadth of the kernels, respectively.
- The 1000 kernel weight tells us about the yield and is also an indicator of soundness. Higher quality varieties will have a greater 1000 kernel weight than low quality varieties.1000 kernel weight was enumerated by multiplying weight of 100 grains by 10 (Soliman, 2009).
- Bulk density is also an indicator of soundness of grains as the grains can be either hollow or

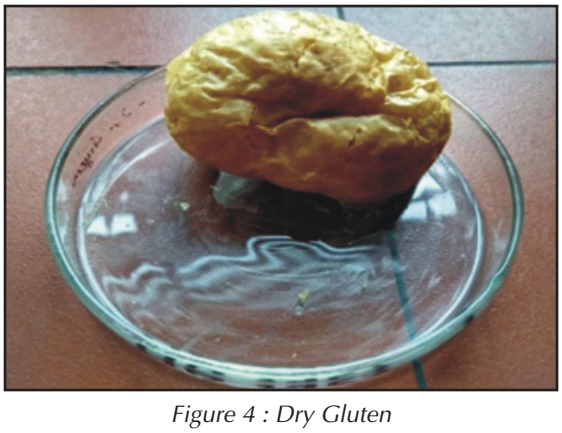

Figure 4 : Dry Gluten

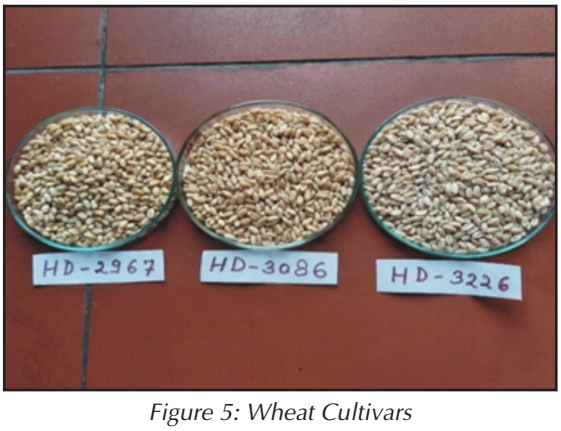

Figure 5: Wheat Cultivars

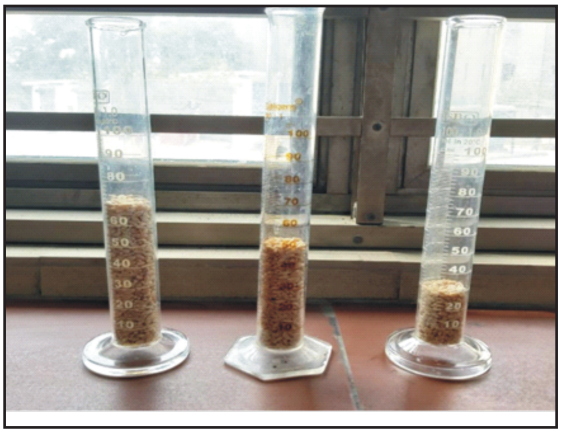

Figure 6: Measuring Bulk density of Wheat HD-3086

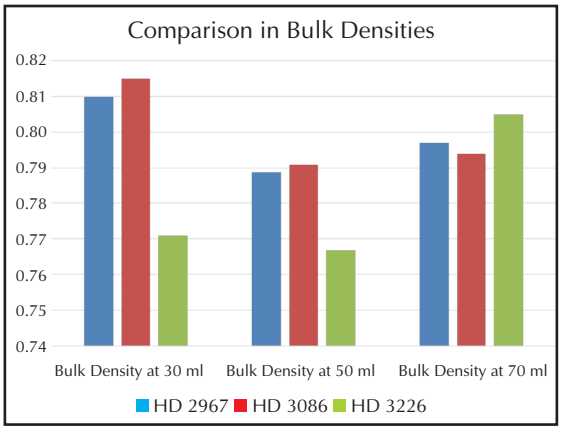

Figure 7: Graph of comparison between Bulk Densities

whole. Low levels of bulk density may indicate insect infestation, foreign matter, and high percentage of moisture content. For the estimation of bulk density, measuring cylinder was used to measure 30, 50 and 70 mLs volume (without tapping) of wheat kernels as shown in figure 6 and then were weighed. Values were put in formula to calculate bulk density (Nelson, 1980; Soliman, 2009). A comparison graph was also plotted as shown in *fig. 7*.

$$Bulk\ Density\ \left(\frac{g}{ml}\right) = \frac{Weight\ of\ Kernels}{Volume\ Taken}$$

- Hectoliter weight is the kernel weight in one hectoliter sample. It is a weight test that

Table :1 Physical Properties and Gluten Content of Wheat Cultivars

Parameters	*HD-2967*	*HD-3087*	*HD-3226*
Color	Creamish brown	Light brown	Rusty brown
Shape	Dented and tapered from 1 end and wrinkled surface.	Slender, tapered, and smooth surface	Tapered from both ends and relatively thick from other two
Size (Mm) **Length** **Breadth**	 5.708 3.750	 6.0985 3.140	 6.152 3.678
1000 Kernel Weight (G)	44.276	40.795	46.415
Bulk Density (g/ml) **30ml** **50 ml** **70ml**	 0.810 0.789 0.797	 0.815 0.791 0.794	 0.771 0.767 0.805
Hectolitre Weight (Kg/hl)	79.913	80.028	78.098

Table:2 Gluten Content of All Three Wheat Cultivars

Parameters	***HD-2967***	***HD-3086***	***HD-3226***
Water Absorption	64 %	64%	68%
Wet Gluten Percent	26.28%	22.62 %	37.3%
Dry Gluten Content	8.77%	7.36%	12.35 %

determines the kernel soundness. It is 100 times the bulk density. (Nelson, 1980)

3. Result & Discussion

The variety HD-3226 was found to be superior in size, shape, 1000 kernel weight, wet gluten and dry gluten followed by HD-2967 and HD-3086 *(Table:1)*. However, HD 2967 was observed with high bulk density and hectolitre weight in comparison to the others. HD-3226 required the highest amount of water during kneading, hence showing the highest percentage water absorption among the three varieties. The swelling of gluten on drying at 235℃ for 15 minutes was observed to be the most in the wheat variety HD-3226, followed by HD-2967 and then by HD-3086. Many kernels of HD-3226 variety were found to be blackened as well as hollow, showed insect infestation in grains due to poor storage conditions. Flour of HD-3086 cultivar was slightly darker in colour in contrasts to other two cultivars. Wet and dry gluten contentwas estimated more in HD-3226 cultivars followed by HD – 2967 and then HD-3086 (Table:2). As the protein content was found out to be higher in variety HD-3226 , this variety will said to have possibly better baking quality than other two cultivars as gluten formed by this cultivar will have better extensibility and elasticity resulting in greater volume of bread loaf.

4. Conclusion

The gluten content of HD - 3226 is highest among the three cultivars. The wet gluten and dry gluten content estimated (37.3% and 12.35% respectively) is much higher than the IARI standard (30.85% and 10.10% respectively). This may be due to inefficient removal of starch completely by the wash and dry method. The 1000 kernel weight is also the highest and therefore results in a higher potential yield as specified by IARI standards (7.96 t/ha). Bulk density readings show a significant fluctuation, which may indicate a possibility a hollowness of grains due to insect infestation. Some grains were observed to be slightly blackened from the tapered ends. This is possible due to inappropriate storage conditions. HD - 3086 estimated gluten content showed a decrease as compared to the IARI standards for wet gluten (27.45 %) and dry gluten (8.50%). The reason can be manual error, excessive washing of gluten which led to removal of a significant proportion of gluten. In spite of having the highest mean yield (5.77 t/ha) and a higher potential yield (7.52 t/ha) according to IARI standards, the 1000 kernel weight is the least among the three cultivars. The cultivar has the highest bulk density and therefore the soundest grains. Lastly, HD - 2967 exhibited gluten content which matched the IARI standards of wet gluten (27.25%) and dry gluten (9.00%) content. The low 1000 kernel weight as compared to HD - 3226 and low bulk density justified the lower mean yield (5.28 t/ha) and potential yield (7.52 t/ha) as stated by IARI.

The overall quality of HD - 3226 is concluded to be superior to the other cultivars as along with gluten content and the physical parameters discussed, the cultivar was also found to be more appealing in terms of size (highest), shape and colour.

5. Future Prospects

Further studies on the same wheat cultivars are undergoing. To broaden our result aspects, effects of different additives such as shortenings, sugars, salts etc. on gluten quality and quantity will be further experimentally done in future. (Kumar, 2013) Comparison between the bread making

quality of the flour of these varieties will be drawn in ongoing studies (Kaur, 2018). Proximate analysis of characteristics and protein contents of different newly developed cultivars will also be taken into consideration. (Mohan, 2013) (Saxena, 1997) Also estimating the gluten content will be done using advanced scientific methods (Kaushik, 2014).

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