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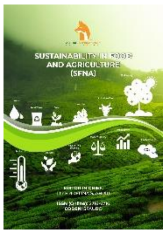

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RESEARCH ARTICLE

EVALUATION OF GERMINATION QUALITY OF WHEAT SEEDS DRIED IN FLUIDIZED BED DRYER

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ABSTRACT

An attempt was conducted taking three wheat varieties (BARI gom-24, Shatabdi, Bijoy) to investigate the application and suitability of single-stage fluidized bed drying for quality wheat seeds in terms of germination percentage. Drying of wheat seed was conducted in a fluidized bed dryer at three temperatures of 35°C, 40°C, and 45°C at a constant bed thickness of 13 cm and 4.5 m/s of air velocity. Total drying time required for drying of each variety 210 min (3.5hr), 150 min (2.5hr) and 80 min (1.3hr) at temperature 35°C, 40°C, and 45°C respectively for reduction of moisture from 16.98±0.15% to 12±0.1% wb. In contrast, sun drying (33±2°C) took 270 min (4.5 hr). It was shown, the drying time required in the fluidized bed drying method was almost 22-71% shorter than the sun drying method. The germination percentage was 94.67%, 97.33%, 88% for the variety “BARI gom-24” 93.67%, 97%, and 91.33% for the variety Shatabdi and 95%, 96.67%, 89.67% for the variety Bijoy while dried in a fluidized bed dryer at temperature 35°C, 40°C, and 45°C respectively. The germination percentage of sun-dried samples was 90.67% (BARI gom-24), 92.33%. (Shatabdi) and 92% (Bijoy). In the comparison of germination, wheat seed samples dried in the fluidized bed dryer at 35°C, 40°C showed a higher germination percentage than sun drying wheat seed samples. Therefore, the proposed drying technique does not only facilitate faster removal of moisture content, and also a higher germination percentage was found than the existing sun drying method. So, fluidized bed drying can be effective for wheat seeds in Bangladesh.

KEYWORDS

Wheat seed, Fluidized bed drying, Germination test, Optimum temperature, Single-stage drying.

1. INTRODUCTION

Wheat (*Triticum aestivum*) goes to the Gramineae family, which is one in each of the vital grains to form flour for food and placental mammal feed. Wheat is also treated as a high source of carbohydrates, vitamin B complex, minerals, and fiber (Sramkova et al., 2009). The world wheat production in 2009-2010 was 685.4 million tons (USDA-WASDE, 2011). The cultivation of wheat is started in Bangladesh in the late 1980s. BARI 2010 reported that Bangladesh is produced around 1 million tons of wheat contrary to the yearly need of 3.0-3.5 million tons. Therefore, every year Bangladesh is brought 2.0-2.5 million tons of wheat to fulfill the pragmatic need. In contrast, postharvest loss of wheat about 3.62% is found in Bangladesh from this 1.54% is storage loss. By improving the drying system with proper drying management storage loss of wheat can be minimized (Bala et al., 2010).

At present, in developing countries, a large quantity of farmers is facing an important problem of low-quality seeds of their crops (CIMMYT, 1999). For any agricultural production, seed quality is an important factor. Low-quality seed decreases the possibility of attainment maximum yields while high-quality wheat seed can conduct to high yield. Besides, some researchers found cultivation with high-quality seed offers several production opportunities to the farmer (McDonald and Copeland, 1997). Simultaneously, the world population is increasing mostly in developing countries. Seed quality development is one of the achievable ways to increase food production in the world. In commercial practice, the germination percentage and physical purity are detrimental characters for characterized quality seed. Frequently, inappropriate (generally too high) moisture content causes the quality loses of seed. Until the moisture in wheat seed reaches a safe level, a wheat seed must be dried under the appropriate environments to prevent the microorganisms and avoid germination in storage.

Before storage, “wheat” seeds require quick drying to avoid germination, respiration, mold damage, and insect infestation. In many places in the world, the harvested wheat moisture content is high and it must be dried down to about 12% to reduce the risk of spoilage in the storage of wheat seeds. (Hoseney et al., 1994) when grain moisture contents are higher than 14%, the fungi present in the grain start to grow. The gluten of wheat is not damaged at the use of temperature under 65°C, which can be liable to protect the viability of wheat seeds (Campana et al., 1986). So, drying is a significant issue to confirm the conservation of wheat seed quality after harvest. The dried product would like less storage space and therefore the drying method creates an easier handle of agricultural products while not losing a motivating quantity of vitamins (Izadifar and Mowla, 2003; Sagar and Kumar, 2010). After harvest, seeds are dry to enhance their shelf life.

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The acceptable moisture content of stored seeds is subjected to the type of species, conditions of storage, and storage time (Copeland and McDoland, 2001). Though there are several drying procedures to dry seeds, completely dissimilar drying procedures may result in dissimilar germination of seed. The response of seed in hot air drying mainly affects the previous history of a crop, species or variety of crop, the amount of moisture content, duration of drying time, and dryer design (Sharada, 2013). Drying condition is additionally very important for maintaining seed quality. Inappropriate drying environments can be the reason for seed damage such as stress cracks, seed germination dropping, grow abnormal seedlings, affecting the seed coat permeability, devastating enzymes (Estrada and Litchfield, 1993; Soponronnarit et al.,1997; Musielak, 2000; Thomson, 1979).

Sun-drying is a natural source of drying and one of the most primitive and common methods of drying wheat seed (Islam et al., 2021). Labor-intensive traditional sun-drying methods for wheat seed drying may not be economic and safe soon where the infestation is common. Grain drying is often categorized as a fixed-bed, spouted bed, and fluidized-bed drying. The fluidized bed dryer is a high-efficiency fluidizing power dryer. The wet products dry in a fluidized bed dryer by heat exchange with gas. Continuous drying during a fluidized bed extends the drying capacity and reduces energy intake. This method has been used commercially and is presently rather common within the drying of food products in several states of the world (Aberuagba et al., 2005). The key components of the fluidized apparatuses are the fluidization container, the solid discharge, and the exit gas dust strainer, the air supplier, and the heat producer.

During this method, the drying airspeed is fixed in such how that the layer of the product is sustained in a fluidized state (Sripawatakul, 1994). In this research, the single-stage drying technique is used in a fluidized bed dryer. This research also focused on the three varieties of wheat seeds (BARI Gom 24 (Prodip), Shatabdi, Bijoy) because of their major roles in the food industry. Drying researches were directed using the fluidized bed dryer at an air temperature of 35-45^{0}C to dry seeds from 18-19%wb to 11-12% wb. The moisture content and quality of dried seeds dry in the experiments were tested. This experiment investigates the application of fluidized bed drying technique, to identify the effect of fluidized bed drying on germination percentage and select suitable fluidized bed drying parameters for quality seeds based on germination percentage. The results of the projected experiment can play a vital role in the enhancement of the socio-economic status of the seed manufacturers and processors while the female workers who are involved in seed drying services will be able to increase their income.

2. MATERIALS AND METHODS

2.1 Collection of Seed Samples

Freshly harvested wheat samples (BARI Gom 24 (Prodip), Shatabdi, and Bijoy) were collected during the harvesting season (March-April in 2018). To get fresh and quality samples, wheat samples were winnowed. On that day, the prepared samples were subjected to drying operation.

2.2 Sample Preparation

Each collected sample from the farmer's field had an average moisture content of 16.98±0.15% wb. The wheat samples were physically cleaned to eliminated impurities such as leaves, broken stalks, and chaff. Also, the samples were separated from the other varieties, immature seeds, and unfilled seeds. Bamboo sieves were used for cleaning the samples from other impurities.

2.3 Moisture Content Determination of the Samples

The amount of moisture content of the freshly harvested wheat samples was ascertained by using the oven method (AOAC, 2005). During the drying operation, the dried wheat sample's moisture content was ascertained by a Digital Grain Moisture meter (GMK-303RS, Korea). The meter was standardized with the oven method before using it. Moisture content was ascertained according to the formula.

$$MC_{wb} = \frac{\text{The initial weight of the sample - The bone dry weight of the sample}}{\text{The initial weight of the sample}} \times 100\%$$

Where,

MC_{wb}= moisture content on a wet basis.

2.4 Experimental Procedure of Wheat Seed Drying

2.4.1 Single-Stage Drying Experiments

In the experiment, single-stage drying in a fluidized bed dryer of wheat seeds was accomplished. Drying operations were carried out by a lab-scale fluidized bed dryer. As the freshly harvested wheat samples contained moisture content less than 18% so, only single-stage drying in a fluidized bed dryer was accomplished.

2.4.2 Experimental Dryer Used for Seed Drying

The experimental dryer which was used in this experiment was previously designed and installed in the Department of Food Engineering and Technology laboratory at Hajee Mohammad Danesh Science and Technology University, Dinajpur. The dryer form of a cylinder-shaped fluidized bed column height of 100cm, an 18kWh unit electric heater, and the power of blower motor 2.24 kW (3hp).

2.4.3 Selecting Optimum Bed Thickness

Before starting the drying operation, the blower was switched on 5-10 minutes before switch the electric heater to heat ambient air until the wanted drying temperature was raised. A high-temperature Anemometer (Model: Kanomax Anemomaster 6036) was used to measure the velocity of air. Several quantities of trial operations were performed for selecting the appropriate FBD bed thickness for optimal fluidization and to the invention the mandatory drying time in the removal of moisture from freshly harvested wheat from 16.98±0.15% wb to 12.0±0.1%wb. Through the trial operation, 12, 13, and 14 cm bed thicknesses were considered for detecting appropriate fluidization in the drying bed. By the trial operations, the sample's nice fluidization behavior was found at 13 cm bed thickness and all experiments were directed at that bed thickness. The time necessary for reducing the seed initial moisture content to the final moisture content of (12.0±0.1% wb) was calculated as drying time.

2.5 Drying Procedure

Firstly, switched on the blower and after few minutes the heater was switched on until the wanted drying air temperature of 35°C, 40°C, and 45°C were found. A Thermocouple (TM 1296, Taiwan) was used to measure the temperature of the air. Then 3.5 kg wheat sample was laden to the fluidized bed drying compartment through the inlet port for keeping a fixed bed thickness of 13cm. Wong stated the wheat seeds might be dried without degradation of seed quality at 40°C drying air temperature from moisture content 18%wb to safe moisture content (≤14%wb) by heat pump dryer (Wong, 2004). A group researchers claimed that 43°C temperature is the upper limit drying air temperature is safe for drying most seeds without injury (McDonald and Copeland, 1997; Soponronnarit, 1997). Based on previous wheat seed drying information, three drying temperatures of 35°C, 40°C, and 45°C were selected for this experiment for reducing moisture content 16.98±0.15% wb to 12.0±0.1% wb. Because (12.0±0.1% wb) this moisture content is out of danger of dried wheat to inhibit fungal infestation, insects, and mites. The Digital Grain Moisture meter was used to measure the sample's moisture content at 30 min intervals during drying.

2.6 Drying of Control Sample

The wheat sample was completely dried by the sun-drying process was considered as the control drying method and the samples were control drying samples. The control drying air temperature was 33±2°C. A hygrometer (Clock & Hygro-Thermometer, Zeal, UK) was used to measure temperature and relative humidity. The samples were spreading at 2-3 cm thickness on the pavement surface. The Digital Grain Moisture meter was used to measure the sample's moisture content at 30 min intervals during drying. Drying was sustained until the wanted final moisture content of 12.0±0.1%wb was accomplished. This is the most common drying method used by the seed processors of Bangladesh. The conventional drying method was accomplished for comparing with the proposed drying method using three temperatures.

2.7 Storage of Dried Wheat Seed Samples

In the polythene bags, all the dried samples were sealed tightly and stored in surrounding environments for about three months. The bags were put on a desk in the laboratory. The samples were observed at some days intervals to inspect insects or mites that damage the seeds. The temperature and relative humidity of the laboratory were 26-30°C and 60-70%.

2.8 Statistical Analysis

A single-factor test in a completely randomized design (CRD) statistical analysis was performed. The drying option was only one factor.Three replication were used for CRD. Mean values, standard error mean (SEM), and analysis of variance of obtained values from germination percentage were calculated by the SPSS statistics statistical software version 25.

2.9 Experimental Design for Germination Estimation

To identify the effect of drying options on quality seeds, a single-factor Completely Randomized Design was applied for quality estimation. There was only one factor was drying options which had 4 levels (treatments) for example fluidized bed drying at 35°C (T_1), at 40°C (T_2), at 45°C (T_3), and sun-drying (T_4).

2.10 Germination Test Procedure of the Dried Wheat Seeds

All the collected dried wheat seed samples were conducted for germination test to know the effects of drying conditions. For the standard germination test, the seed samples were placed in aluminum dishes overnight under the surrounding environment to balance with the surrounding temperature and decrease the stress inside the seeds. The seed samples were placed on moist reeled paper cloths in sterilized Petri dishes. The 100 seeds of three replications were accomplished for each sample of wheat. The seed samples were placed on the dishes or trays were placed in the atmosphere at 20-30ºC (Association of Official Seed Analysts, 1978). The seeds which had roots or shoot longer than 2 mm were considered as germinated seeds. After 3 days, germinated seeds were calculated.

The germination percentage was calculated by the following equation:

$$\text{Germination percentage (GP)} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds placed for germination}} \times 100$$

2.11 Uncertainty analysis

According to the relative humidity and ambient air temperature were measured for a period to inspect the measurement accurateness of the hygrometer (Sarker et al., 2015). An anemometer was used to measure the air velocity of airflow produced by the atmosphere. In contrast, a moisture meter was used to determine the moisture content of wheat seeds. All the measurement's mean values and standard deviation on all experimental data were calculated. The uncertainty of the variable X_i can be presented as:

$$X_i = X_{mean} \pm \delta X_i$$

Where the original value of the variable is X_i, the mean value of the measurements is X_{mean}, and the uncertainty of the measurement is δX_i. The Higher is the δX_i the higher is uncertainty in X_i. Then the percent uncertainty was determined as the ratio of the uncertainty, δX_i to our best approximation, X_{mean} has mentioned to the fractional uncertainty. Naturally, the uncertainty is lesser compared to the calculated value, therefore it is appropriate to multiply the fractional uncertainty by 100 and account for the percent uncertainty by the following equation:

$$\% \text{ Uncertainty} = \text{Fractional Uncertainty} \times 100$$

3. Results and Discussion

3.1 Outcomes from Trial Drying Operation of Wheat Seeds in Fluidized Bed Drying

The trial operation indicated that when low moisture wheat was dried at 13 cm bed thickness within 20 cm diameter of the drying chamber then proper fluidization was accomplished. The bed air velocity was found at 4.5 m/s for the consistent total airflow rate of 0.14 m^3/s. If the velocity of air is about too high, then the wheat is progressively mortified because of the development of outsized bubble size. Therefore, drying experimentations were accomplished at 13 cm bed thickness to eliminate any difficulty concerning the above or below the fluidization procedure.

3.2 Drying Behavior of Wheat Seeds Dried in Fluidized Bed Dryer

The drying curve of wheat seeds drying in the fluidized bed dryer is shown in the following figures.

3.3 Drying Behavior of Variety "BARI ghom-24 (Prodip)" Dried in Fluidized Bed Dryer

Figure 1 indicated that the time needed to reduced moisture content from 16.98±0.15% to 12.0±0.1% wb at 35°C, 40°C, and 45°C temperature was 210min (3.5hr), 150 min (2.5hr) and 80 min (1.3hr) respectively. The air velocity during fluidized bed drying was 4.5 m/s.

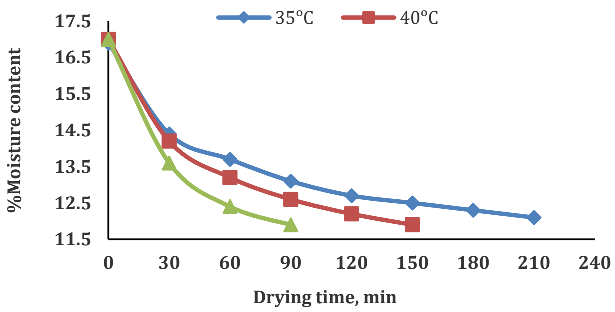

Figure 1: Drying curve of wheat seeds (Variety: BARI gom-24) dried in fluidized bed dryer at 35°C, 40°C, and 45°C

3.4 Drying Behavior of Variety "Shatabdi" Dried in Fluidized Bed Dryer

Figure 2 indicated that 210min (3.5hr), 150 min (2.5hr), and 80 min (1.3hr) was needed to reduced moisture content from 16.98±0.15% to 12.0±0.1%wb at 35°C, 40°C, and 45°C respectively. The air velocity during fluidized bed drying was 4.5 m/s.

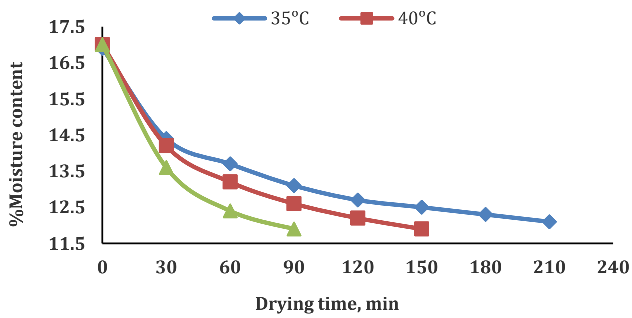

Figure 2: Drying curve of wheat seeds (Variety: Shatabdi) dried in fluidized bed dryer at 35°C, 40°C, and 45°C.

3.5 Drying Behavior of Variety "Bijoy" Dried in Fluidized Bed Dryer

Figure 3 indicated that time needed to reduce moisture content moisture from 16.98±0.15% to 12.0±0.1%wb at 35°C, 40°C, and 45°C were 210min (3.5hr), 150 min (2.5hr), and 80 min (1.3hr) respectively. The air velocity during fluidized bed drying was 4.5 m/s. The drying process observed during the drying was faster yet together constant rate and falling rate stages were developed as depicted in the above figure. It denoted a natural and gentle moisture extraction of a similar midway moisture crop (Vega et al., 2007). A similar movement was detected during the drying of food products in a fluidized bed (Tasirin et al., 2014). The result denoted that the drying time was shorter because superior heat and mass transmission happened throughout drying (Soponronnarit et al., 1997). The drying rate normally rises with an increased grain moisture content and temperature of the air, on the other hand, reduce with an increased humidity of air (Trim and Robinson, 1994). Considering the results of wheat seeds dried in a fluidized bed dryer, it was proved that the upper drying temperature of air leads to a quicker drying rate. From the above drying curves, it was shown the drying curve and drying time were almost the same for the three varieties. So, it could be decided that wheat seeds dried in a fluidized bed dryer did not affect variety.

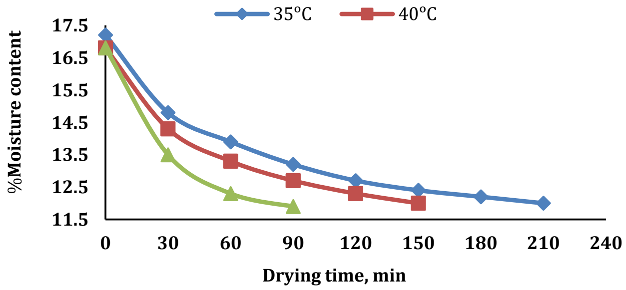

Figure 3: Drying curve of wheat seeds (Variety: Bijoy) dried in fluidized bed dryer at 35°C, 40°C, and 45°C.

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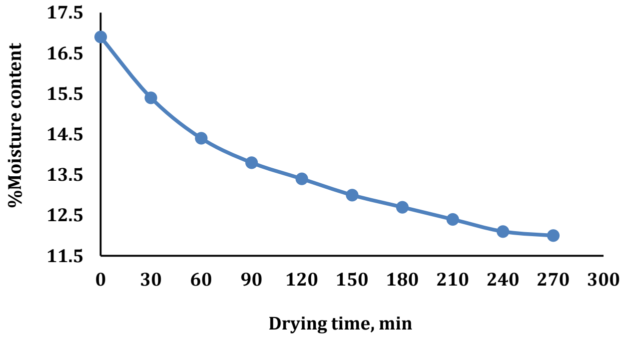
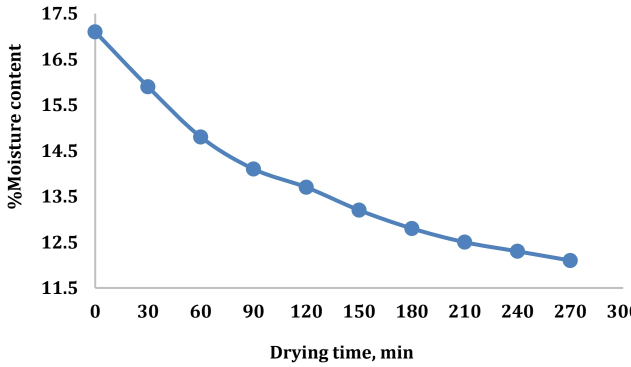
3.6 Drying Behavior of Wheat Seeds in control drying method



(a)



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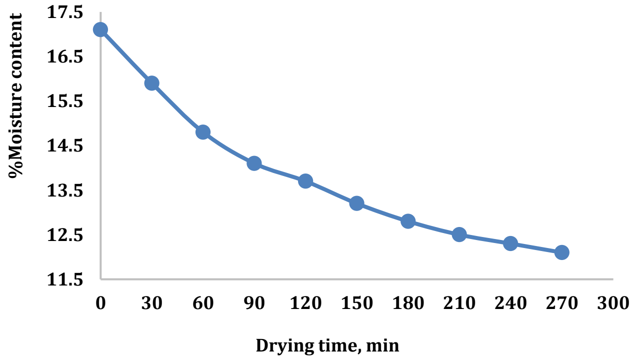


(c)

Figure 4: Drying curve of sun-dried wheat seeds (Variety: BARI gom-24(a), Shatabdi(b), Bijoy(c)).

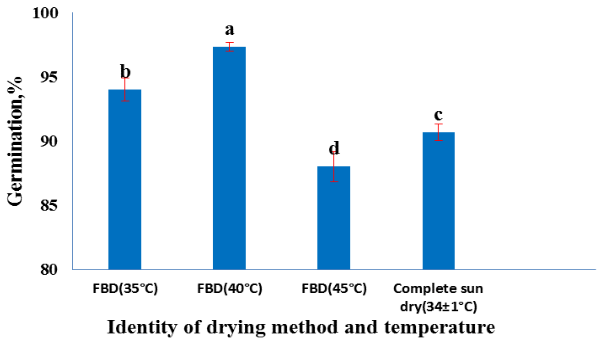
The drying curve of the sun-dried samples is shown in figure 4 above. From the samples, moisture content was reduced from 16.98±0.15% to 12.0±0.1% wb. The temperature of the atmosphere was 33±2°C and the relative humidity of the air was 52-62%. The velocity of air was 0.4-0.5 m/s. In control drying samples, the time essential to bring the initial moisture to the final moisture was 270 min (4.5 hr). During the sun drying of BARI gom-24 temperature was 34±1°C, relative humidity was 56-62% and air velocity rate was 0.4-0.5 m/s. The drying curve is shown in Figure 4(a). During sun drying of Shatabdi, the temperature was 33±1°C, relative humidity was 55-61% and air velocity rate was 0.4-0.5 m/s. The drying curve is shown in Figure 4(b). During sun drying of Bijoy, the temperature was 33±2°C, relative humidity was 52-60% and air velocity rate was 0.4-0.5 m/s. The drying curve is shown in Figure 4(c). The graph showed that rapid moisture removal occurred when the grain contains high moisture but the moisture removal process was slow when the moisture content of wheat was low.

3.7 Drying Time Comparison between Sun Drying (Control Drying) and Fluidized Bed Drying

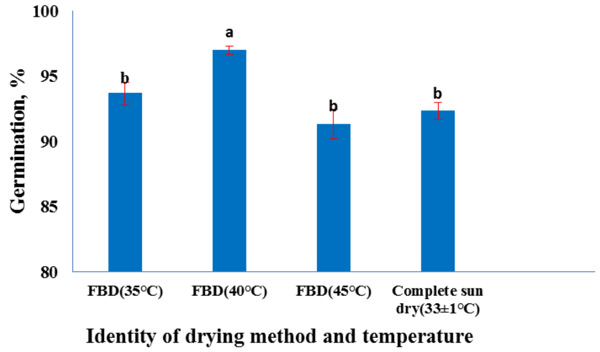
The time required in the existing sun-drying was 270 min (4.5 hrs) for reducing moisture content 16.98±0.15% to 12±0.1% wb during the drying of the same wheat seed samples as shown in Figure 1 to 4 The result indicated that this method took 1.3-3.4 times higher than the fluidized bed drying. On the other hand, it was found that at the farm level the drying time to be different from two or three days depending on the situations of the environment. It was shown that the drying time required in the fluidized bed drying method was almost 22-71% lower than the sun drying method (Bola et al., 2013). The grain will continue to deteriorate because of the slow rate of drying if the grain is put on the land to dry. Labor intensive using traditional sun-drying methods of wheat seeds drying may not be economic and safe soon where the infestation is normal. So, the necessity of a mechanical dryer is significant for the profitable drying of wheat seeds.

3.8 Comparison of Germination Percentage between Fluidized Bed Drying and Sun Drying Samples

The comparison of germination results between fluidized bed drying and sun drying samples is shown in Figure 5. In the statistical analysis shown in figure 5(a), The level of significance was 5%. In the graph, it was noticed that 97.33% was the highest value in T_2. It was different from others. The bottommost value (88%) was initiate in T_3. In the statistical analysis shown in figure 5(b), The level of significance was 5%. From the result, the highest value is 97% was found in T_2. It was not like to others. The lowest value 91.33% was found in T_3. It was similar to T_1 and T_4. That means there were no significant differences among T_1, T_3, T_4. In the statistical analysis shown in figure 5(c), The level of significance was 5%. In the graph, it was shown that the maximum value (96.67%) was found in T_2. It was similar to T_1. That means these were statistically similar. They were significantly indifferent between. In T_3, the bottommost value was found at 89.67%. It was similar to T_4.



(a)



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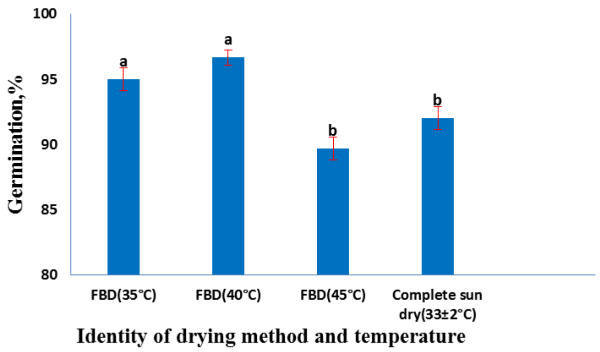

(c)

Figure 5: Comparison of germination percentage of wheat seeds (Variety: BARI gom-24(a), Shatabdi(b), Bijoy(c)) dried by fluidized bed drying temperature and sun-drying temperature. a-d the test values: dissimilar letters for the germination percentage in the column indicate that the values are significantly different.

The germination capacity of the variety "BARI gom-24" dried in fluidized bed drying at 35°C was 94.67%, at 40°C was 97.33% and 45°C was 88%. The sun-drying samples for the same variety, germination percentage was 90.67% which was dried at the temperature of 33±2°C. It was shown, the germination percentage of fluidized bed drying samples at 35°C (94.67%) and 40°C (97.33) was higher than the sun-dried samples (91%). Only, the germination percentage of sun-dried samples was greater than the fluidized bed drying samples which were dried at 45°C (88%) temperature. The "Shatabdi" wheat dried at the temperature 35°C, 40°C, and 45°C in the fluidized bed dryer, yielded a germination percentage of 93.67%, 97%, and 91.33% respectively. Also, the sun-dried samples' germination percentage was 92.33%. The Bijoy wheat was dried at the temperature at 35°C, 40°C, and 45°C in the fluidized bed dryer, which yielded a germination percentage of 95%, 96.67%, and 89.67% respectively. Also, the germination percentage of sun-dried samples was 92%.

The results indicated like as the above two varieties the germination capacity of the samples dried in FBD at 35°C, 40°C was greater than the sun drying samples but the percentage of germination of the samples which were dried at 45°C temperature in a fluidized bed drier were less than the sun-dried samples. Madamba and Yabes denoted the highest value (92%) drying of rice seeds at the temperature of air 35°C and indicated that when using lower drying temperatures, the dried seeds germination capacity tends to rise (Madamba and Yabes, 2005). The highest germination capacity (88%) of hybrid rice seed in thin layer drying at 40°C drying temperature (Hasan et al., 2014). The maximum germination percentage of rice seeds was found at the first stage 50°C and the second stage 35°Cdrying air temperature dried in a fluidized bed dryer (Islam et al., 2021). In this research, the highest germination percentage was found for wheat seeds at 40°C dried in a fluidized bed dryer. A group researchers stated the maximum germination percentage of maize seed was 91.47% in 15 hr in thin layer drying at 42°C temperature (Hossain et al., 2015). But in this experiment, the highest percentage was found (97.33%) of wheat seed in 2.5 hr drying at 40°C in fluidized bed drying.

These results also indicate the germination capacity of wheat seed samples dried in a fluidized bed dryer is an increase in the increase of temperature 35-40°C, then decreases with the increase of temperature. Considering the germination test results of wheat seeds dried in FBD, it was indicated that the drying air temperature, initial moisture content, and drying time had an important effect. Additionally, longer drying time and higher drying air temperature were showed an adverse effect on the germination of seed. It could be decided that the safe drying temperature was 40°C for the wheat seeds which had an initial moisture content of 16.5-17.6 %wb. The proposed drying practice did not only enable quicker subtraction of moisture but also greater germination of dried wheat seed comparison to the existing sun drying technique. So, fluidized bed drying can be effective for wheat seeds in Bangladesh.

3.9 Result of Uncertainty Analysis

The uncertainty analysis results are shown in Table 1 in below:

Table 1: List of measuring instruments with their specifications, accuracies, and uncertainties of measured quantities

Name of the instrument	Specification	Accuracy	Measured parameter	Standard deviation	Uncertainty (%)
Anemometer	Kanomax Anemomaster, 6036, USA.	± 3%	Air velocity	±0.01	±2.52
Hygrometer	Clock & Hygro-Thermometer, Zeal, UK.	±1°C	Relative humidity of ambient air	±2.10	±2.50
		±5%	Temperature of Ambient air	±0.22	±0.68
Digital grain moisture meter	GMK-303RS, Korea.	±0.5%	Low moisture of wheat	±0.15	±0.88

4. Conclusions

An attempt was conducted to evaluate the germination quality of wheat seeds dried in a fluidized bed dryer. In this research three varieties (BARI gom-24, Shatabdi, Bijoy) were used to investigate the application and suitability of single-stage drying of wheat seed in fluidized bed dryer in terms of germination percentage. Total drying time required for drying of each variety 210min (3.5hr), 150 min (2.5hr) and 80 min (1.3hr) at the temperature 35°C, 40°C, and 45°C respectively for reduction of moisture from 16.98±0.15% to 12±0.1% wb. But in contrast, time was required 270 min (4.5 hrs) for the sun drying (33±2°C) method. It was shown that the drying time required in the fluidized bed drying method was almost 22-71% shorter than the sun drying technique.

The experiment also showed higher drying air temperature reduced the drying time and ultimate moisture content of the dried wheat seed. The germination percentage of the variety "BARI gom-24" was 94.67%, 97.33 %, 88% dried in a fluidized bed dryer at 35°C, 40°C, and 45°C temperature respectively. The percentage of germination was 93.67%, 97%, and 91.33% for the variety Shatabdi and 95%, 96.67%, and 89.67% for the variety Bijoy while fluidized bed drying at the temperature 35°C, 40°C, and 45°C respectively. The percentage of germination of sun-dried samples was 90.67% (BARI gom-24), 92.33%. (Shatabdi) and 92% (Bijoy). In the comparison of germination, it is shown that in the fluidized bed drying wheat seed samples germination percentage was higher when dried at 35°C, 40°C than the sun drying wheat seed samples. Drying air temperature has an important effect on seed germination percentage.

The maximum germination percentage was found at 40°C drying temperature. Germination percentage reduced with the above 40°C drying air temperature. Finally, it is determined that the drying air temperature should not exceed 40°C temperature when wheat seeds are dried in a fluidized bed dryer. From the results, it was shown the drying curve and drying time were almost the same for the three varieties. So, it could be determined that wheat seeds dried in a fluidized bed dryer did not affect variety. The proposed drying procedure did not only simplify quicker subtraction of moisture content but also a greater germination percentage of dried wheat seeds compared to the existing sun drying method. So, fluidized bed drying can be effective for wheat seeds in Bangladesh.

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