Value Addition in Green Peas by Drying Under Fluidized Bed Drying

Abstract

India's diverse climatic conditions provide advantages for the production of fruits and vegetables, ensuring year-round availability of various fresh produce. *Pisum sativum* (peas), a significant vegetable crop in India, contributes approximately 2.5% (3.86 million MT) to total vegetable production and accounts for 4.6% of the vegetable-growing area (NHB, 2014). However, due to their high moisture content, peas cannot be stored for extended periods and require preservation methods such as freezing, canning, cold storage, or drying (Chauhan and Srivastava, 2009).

This study evaluates fluidized bed drying of green peas as a preservation method to enhance farmers' income, particularly in Gujarat. The investigation included two pre-treatments (unblanched and blanched), three bed heights (20, 40, and 60 mm), and three drying air temperatures (45°C, 55°C, and 65°C). Mature, fresh green peas were manually deshelled, blanched at 85°C for 1 minute, cooled under running water, and surface moisture was removed before drying.

Results revealed that drying occurred entirely in the falling rate period, with the overall drying rate ranging from 0.0053 to 0.0158 kg water/kg dry matter/min. The maximum drying rate (0.0158 kg water/kg dry matter/min) was observed with the blanched sample at a bed height of 20 mm and 65°C. The highest protein content (17.87 g/100g) was recorded at 45°C, similar to 55°C (17.85 g/100g). The highest chlorophyll content (106.98 mg/100g) was observed in blanched samples dried at 40 mm bed height and 45°C, comparable to 55°C (106.68 mg/100g). The highest rehydration ratio (3.53) was achieved in blanched samples at 40 mm bed height and 55°C.

It is concluded that blanching green peas at 85°C for 1 minute, followed by fluidized bed drying at 40 mm bed height and dry air temperature at 55°C, produces high-quality dried peas with good qualities.

Key words: Green peas, Physico-chemical properties, Fluidized bed drying, Quality parameters

INTRODUCTION

In India it ranks second in production of fruits and vegetables globally following China. “As per Indian Horticulture Database, India produced 204.96 million MT of vegetables during

2023-24, Out of which, *Pisum sativum* (commonly known as peas) is one of the major vegetable crop contributes approximately 2.5% (3.86 million MT) share of the total vegetable production and 4.6% of the total vegetable producing area in India" (*NHB, 2023-24*). According to NHB date base 2021-22, the area and production of green peas is estimated as 549,000 Ha and production is about 5680,000 MT and According to FAO statistics, the worldwide green pea production in 2023 was about 9.9 billion tons. Green pea acreage ranks fourth among the vegetables. "The medicinal action of green peas are antioxidant and anti-inflammatory, blood sugar regulation and heart health promotion and the medicinal uses are heart disease, diabetes, stomach cancer and ulcers, etc."(*Nutrition,2015*). "It is also highly nutritive and contain high content of digestible protein (7.2 g/ 100g), carbohydrate (15.8 g), Vitamin-C (9 mg), phosphorus (139 mg), minerals and also is low in fat, high in fiber, and has no cholesterol so that it has been used in the human diet for a long time. But they are available only during winter season. And the life span also very low. They are used for making vegetables, as additives in certain vegetables and for making several snack preparations. But the shelf-life of green peas is not more than 3-4 days. In Indian the major pea producing states where peas are grown and farmers mostly sold in local mandies at very low price of 10-15 Rs/kg depending upon the quality. Peas are highly perishable, fresh unshelled peas may be kept for two weeks at 0°C with 90-95 % RH whereas processed peas i.e shelled frozen peas can be stored at -23 to -18°C for one year when packed in gas tight packaging or it can also be dried for selling it as dry pea or mutter. Due to its high moisture content, it cannot be stored well for a long period of time and must be subjected to some method of preservation such as, freezing, canning, cold storage or drying in order to make it available for later consumption" (*Chauhan and Srivastava, 2009*).

"Physical and chemical parameters are important attributes of green peas seeds and it is used in grading, sorting and determination of seed surface area which correlate the machine design parameters for different agricultural processes such as handling, harvesting, threshing, cleaning, conveying, sorting, drying. Pre-treatment i.e. blanching prevents the loss of colour by inactivating enzymes, relaxing tissue structure with better quality yields of a finished product. Green peas are blanched in hot water at 85°C for 1 minute immediately cooled under running cold water for at least 3 minutes and then their surface moisture removed" (*Doymaz and Kocayigit, 2011*). "Fluidization is widely used when processing solid particles in such technologies as drying,

combustion, synthesis, etc. Generally, fluidized bed dryers are considered superior to other conventional dryers when processing non sticky and small size distributed particles. Once, the air is allowed to flow through a bed of solid material with a velocity greater than the settling rate of the particle, the solid particle become blown up and suspended in the air stream. At this stage, solid particle looks like a boiling stage; therefore this stage is called fluidized. Use of hot air in the fluidized bed will increase the drying rate of the material" (*Parlak et. al., 2003; Senadeera, 2005; Honrvar et al., 2011*).

METHODOLOGY

The data collected during the experimentation on 18 treatments with 3 repetitions were subjected to statistical analysis of Factorial Completely Randomized Design (FCRD). The treatments consist of Factor 1: Pre treatment (P) (2 Level) i.e.P1 = Unblanched and P2 = Blanched (85 ^{o}C for 1min); Factor 2: Bed Height (H) (3 Level) i.e.H1 = 20 mm ;H2 = 40 mm; H3 = 60 mm Factor 3: Drying Air Temperature (A) (3 Level)i.e.A1 = 45 ^{o}C;A2 = 55 ^{o}C;.A3 = 65 ^{o}C. Fresh green peas were procured from the APMC market, Navsari District, Gujarat. The green peas pods were thoroughly washed to remove the dirt adhering to pods. Damaged and diseased pods were sorted out. After the sorting of pods, shelling was done manually by hands and seeds were graded according to their size. Then green peas seeds were blanched at 85°C for 1 min (for blanched treatment only) and cooled in running water and removed the surface moisture. The fresh and bone dried weights were used to calculate the moisture content which was expressed as kg water / kg dry matter. The initial moisture content of green peas had 3.347 kg water / kg dry matter. The green peas were used for drying in fluidized bed drying set up. For each experiment, about 6 kg of sample was used and a final moisture content of 3.5 to 3.6 % (db). Experiments were carried out in triplicate and average value was taken for calculation.

Fluidized bed drying: The fluidized bed dryer set up (*Neelam Industries,* Ahmadabad, India) is made up of stainless steel which has the operating temperature level l0 to 180°C. The capacity of chamber (470 mm × 470 mm x 1000 mm) with 4-50 kg of wet fruit and vegetable material. A detachable bowl is placed at the bottom of the dryer, which is used for charging and discharging (product container).The bowl has a perforated bottom with a wire mesh support for placing materials to be dried. A fan is mounted in the upper part for circulating hot air. Fresh air inlet and pre-filter are connected serially to heat the air to the required temperatures. The temperature of hot

air and exit are monitored. Bag filters are placed above the drying bowl for recovery of fines. Drying was performed in the combination of pre treatment, bed height and temperature level as per the treatment. The hot air passing through the material bed was kept at a constant value for the experiment. Then the final prepared materials were put in to the fluidized bed for drying purpose. Sample weighing 4.5, 9.0 and 13.5 kg of green peas were taken as treatment for bed height levels of 20 mm, 40 mm and 60 mm, respectively and pre treatments of blanching and without blanching was done to load the material in detachable bow. Three different bed height levels of 20 mm, 40 mm and 60 mm and three different temperature levels of 45, 55and 65 ºC were taken. Samples were taken out at regular interval of 30 minutes from the dryer for taking the readings of weight reduction and changes in volume. Weight loss was recorded after each treatment using the digital weighing balance (SWISSER, India). The drying set-up was run for 10 minutes to achieve steady state conditions of drying before material introduction.

Moisture content (% w.b.)

"Moisture content of fresh as well as dried green peas was determined in accordance with standard procedures in a hot air oven" (*AOAC, 1990*). The moisture content was calculated on wet basis

$$\text{Moisture Content (\% wb)} = \frac{(\text{fresh weight} - \text{dry weight})}{\text{fresh weight}} \times 100 \ldots\ldots (1.0)$$

Drying rate

The drying rate during the experiments of green peas was calculated using the following formula.

$$\text{Rate of drying} = dM/dt = \frac{Mt+dt-Mt}{dt} x100 \ldots\ldots \quad (2.0)$$

Where,Mt =moisture content at instant of time t.

Mt+dt =moisture content at time after an interval of dt .

Total chlorophyll content (mg 100 g^{-1})

The total chlorophyll content of dried green peas samples were determined using method as described by (*Sadasivam and Manickam 1996*). The total amount of chlorophyll present in the extract mg chlorophyll per g tissue was calculated by using the following equations:

$$\text{mg total chlorophyll} g^{-1} \text{tissue} = 20.2\ (A_{645}) + 8.02\ (A_{663})\ x\ \frac{V}{1000\ x\ W} \ldots (3.0)$$

Where, A = absorbance at specific wavelengths

V = final volume of chlorophyll extract in 80 % acetone

W= fresh weight of tissue extracted.

Estimation of Protein (g/100 g)

The protein content was estimated using Lowry's method as described by (*Sadasivam and Manickam 1996*). The amount of protein was expressed in g/100g.

Rehydration ratios:

Dried green peas were rehydrated by immersing in warm water (about 60°C) room temperature. About 50 g of dried samples were placed in glass beakers containing water in ratio 1:25 (w/w) for 60 min. The rehydration ratio was calculated as follows (*Feng & Tang 1998*).

$$\text{Rehydration ratio} = \frac{W_r}{W_d} \quad \ldots\ldots\ldots \quad (4.0)$$

Where, W_r is the rehydrated weight, g

W_d is the dehydrated weight, g

Statistical analysis of green peas sample

"The experimental data were analyzed by factorial completely randomized design (CRD) according to procedure described by" (*Gomez and Gomez 1984*).

RESULTS AND DISCUSSION

The result of the investigation embodies the drying characteristics of green peas (*Pisum sativum* L.). The results along with figures inference obtained were presented and discussed below:-

Overall drying rates

The Overall drying rates for all treatment are presented in Fig.1.Overall drying rate varied from 0.0053 to 0.0158 (kg of water / kg of dry matter)/min for the total range of variables of the study. The maximum overall drying rate i.e. 0.0158 (kg of water / kg of dry matter)/min was observed in treatment P2H1A3 (blanched, 20 mm bed height, 65°C drying temperature) and the minimum Overall drying rate i.e. 0.0053 (kg of water / kg of dry matter)/min was observed in treatment P1H3A1 (un-blanched, 60 mm bed height, 45°C drying temperature). Overall drying rate linearly increases with increase in temperature from 45 to 65°C. It is seen that the overall drying rate decreases with increase in bed height at all experimental temperatures. It is also seen that the overall drying rate slightly lower for un blanched samples than for blanched samples at almost all experimental temperatures. These observations are in line with those reported by (*Kaur et al., 2006*) for coriander leaves.

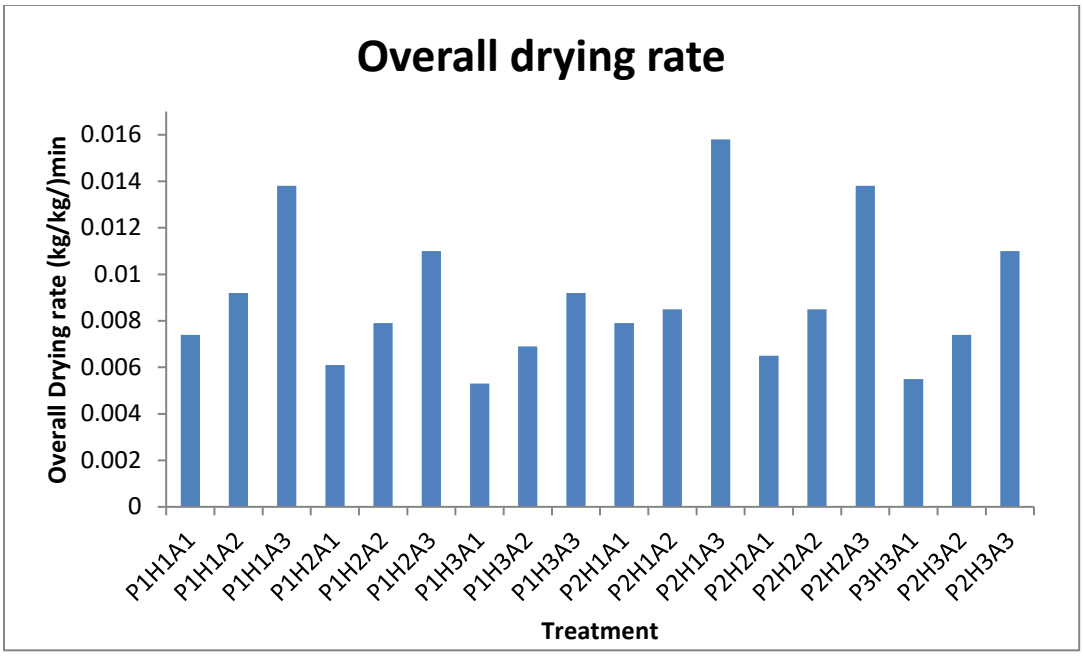

Fig 1. Variation of overall drying rate of fluidized bed drying of green peas

Moisture content of dried green peas:

The data on moisture content (%) of fluidized bed drying of green peas were recorded at immediate after drying and is presented in Fig.2. No significant results were observed as an individual effect of pre treatment, bed height and drying air temperature as well as their interaction effect. The average moisture content was found to be 3.52%.Similar observation was recorded by (*Babu et al.,2011*) in spinach and curry leaves.

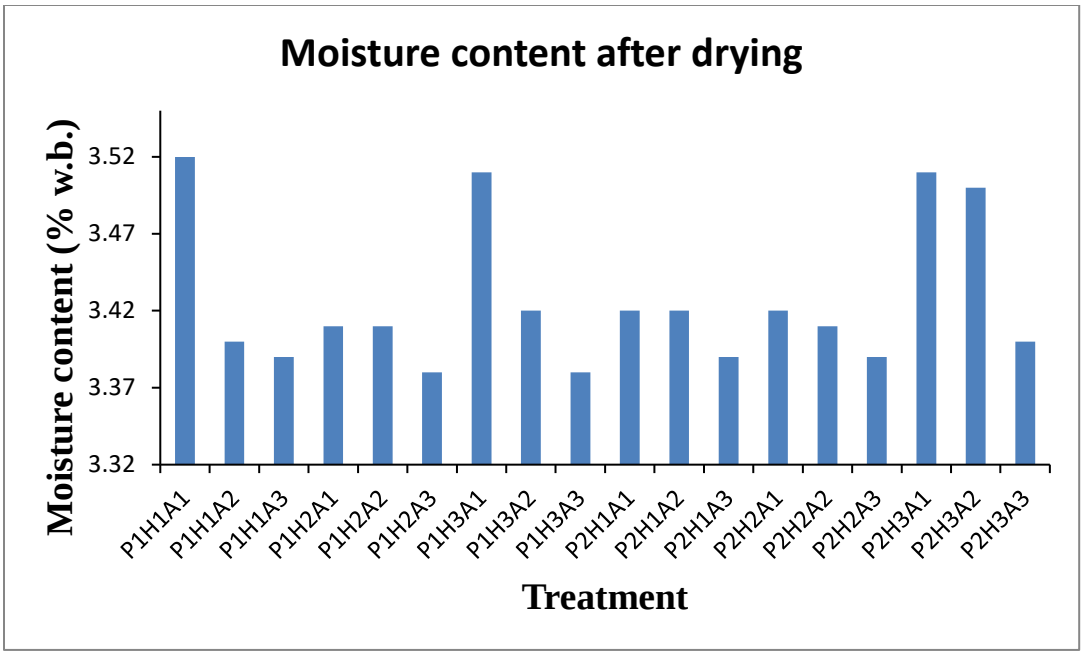

Fig 2. Interaction effect of pre-treatment, bed height and drying air temperature on Moisture content (%) of green peas under fluidized bed drying

Protein (g/100g)

The data on protein (g/100g) of fluidized bed drying of green peas were recorded at immediate after drying and is presented in Fig.3. Non-Significant results were observed as an individual effect of pre treatment and bed height and but significant result was found on the effect of drying air temperature but their interaction effect was found non- significant immediate after drying. The average protein was found to be (17.83g/100 g). Due to higher in temperature, the degradation of protein occurs. There was no significant change of protein during storage. Similar results were obtained by (*Danso-Boateng 2013)* microwave-drying of basil leave and (*Manzoor et al.,2019)* in dried fresh green beans.

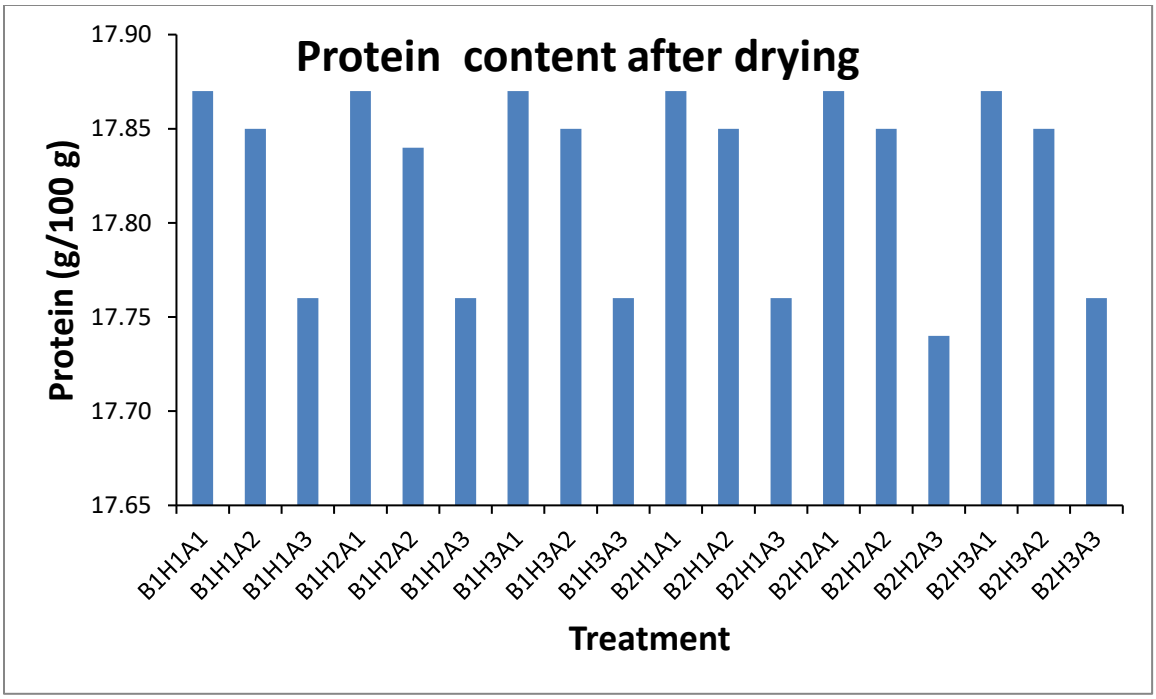

Fig 3. Interaction Effect of pre-treatment, bed height and drying air temperature on protein (g/100g) of green peas under fluidized bed drying

Chlorophyll content (mg/100g)

The data on chlorophyll content (mg/100g) of fluidized bed drying of green peas were recorded at immediate after drying and is presented in Fig.4. The treatment P2H3A1 (blanched, 60 mm bed height bed with 45 °C) i.e., 127.84 mg/100g recorded significantly highest chlorophyll content and while the significantly lowest was found in P1H1A3 (un-blanched, 20 mm bed height bed with 65 °C) i.e., 50.09 mg/100g. From the data it could be revealed that fluidized bed drying, the chlorophyll content of the green peas increases when applied pre treatment i.e. due to blanching effect, decrease with increase in the bed height level and decreases with increase in drying air temperature. This may be to the fact that chlorophyll degradation in green peas is temperature dependent and followed first order reaction kinetics (*Ahmed et al., 2004*). Higher chlorophyll content for treated samples may be because of blanched treatment. The lower chlorophyll content at higher temperature was due to inactivation of chlorophyllase enzyme which may be responsible for degradation of chlorophyll.

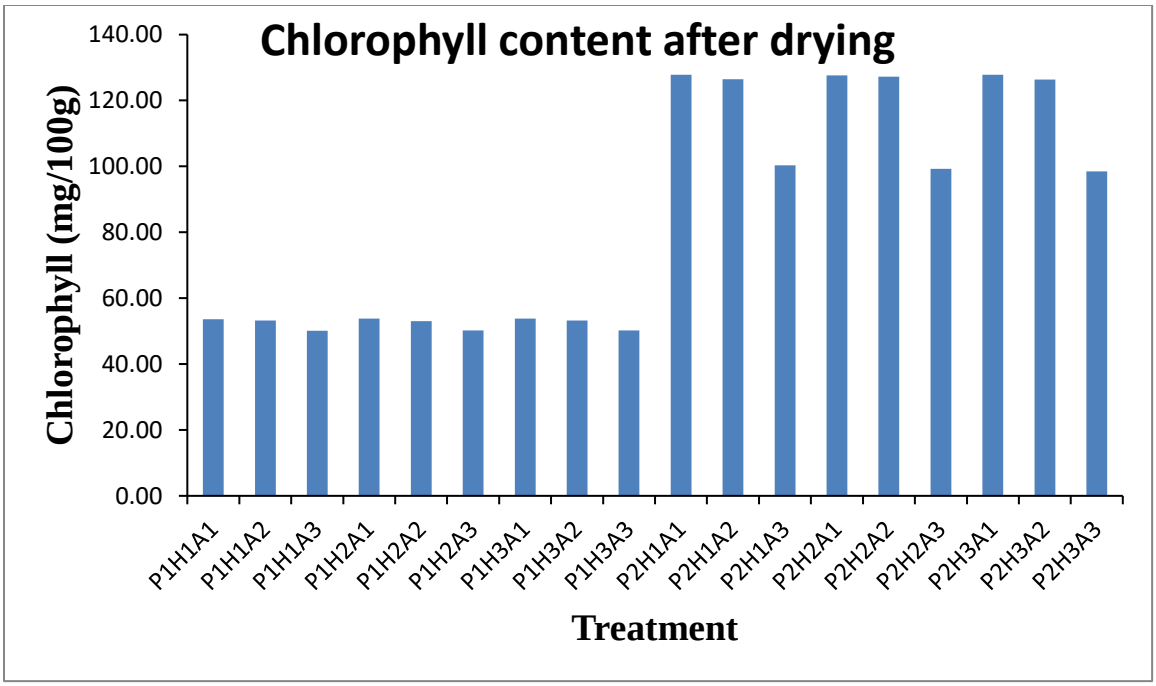

Fig 4. Interaction Effect of pre-treatment, bed height and drying air temperature on chlorophyll content (mg/100g) of green peas under fluidized bed drying

Rehydration ratio

The data on rehydration ratio of fluidized bed drying of green peas were recorded immediate after drying and is presented in Fig.5. The treatment P2H2A2 (blanched, 40 mm bed height bed with 55 °C) i.e., 3.53 recorded significantly highest rehydration ratio which was at par with P2H2A1 (blanched, 40 mm bed height bed with 45 °C) i.e., 3.52 and P2H3A1 (blanched, 60 mm bed height bed with 45 °C) i.e., 3.51.While, significantly lowest rehydration ratio was found in P1H2A3 (un-blanched, 40 mm bed height bed with 65 °C) i.e., 3.33. From the data it could be revealed that fluidized bed drying, the rehydration ratio of the green peas increases when applied pre treatment i.e. due to blanching effect and decreases with increase in drying air temperature. Similar results were obtained by several researchers green peas (*Ahmed et al., 2001*) for mint leaves; (*Therdthai and Zhou 2009)* and for spinach and (*Babu et al.,2011)* for curry leaves.

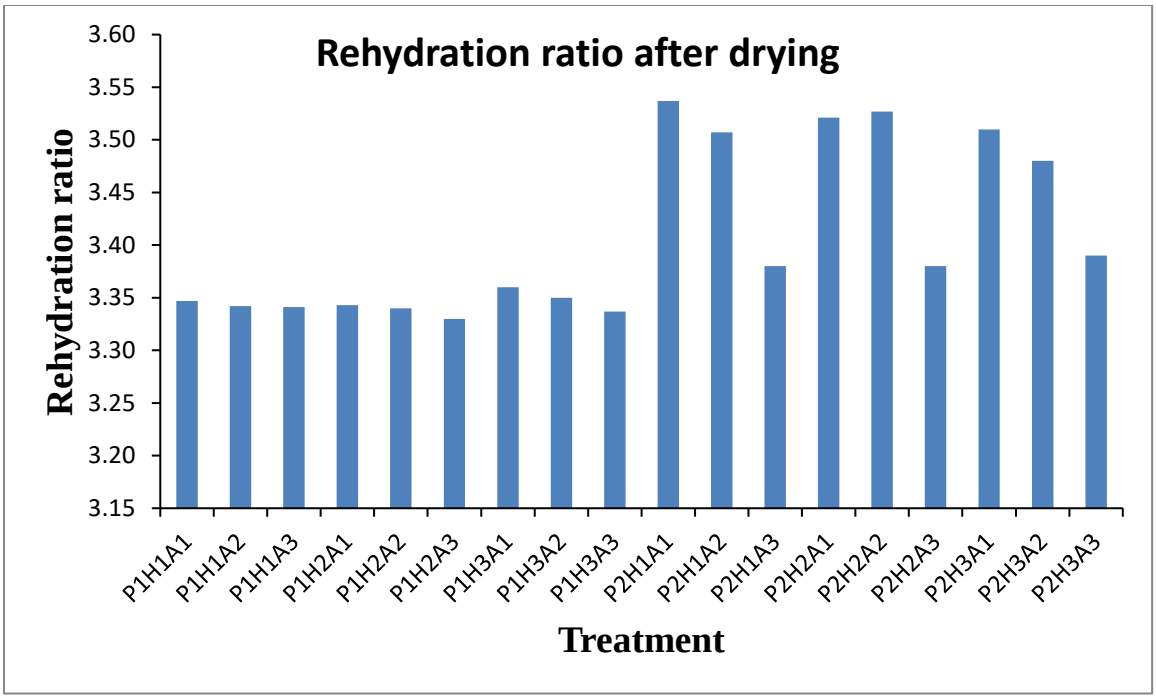

Fig 5. Interaction Effect of pre-treatment, bed height and drying air temperature on rehydration ratio of green peas under fluidized bed drying

CONCLUSION

The drying characteristics of green peas seeds are essential for grading and sorting,as well as for correlating machine design parameters used in various agricultural processes such as handling, harvesting, threshing, cleaning, conveying and drying. The experiment concluded that green peas should be blanched at 85° C for 1 minute before undergoing fluidized bed drying at a bed height 40 mm and a drying air temperature of 55 °C (treatment P2H2A2). This method ensures the production of high-quality dried green peas while preserving their nutritional and sensory properties.

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Details of the AI usage are given below:

1.

2.

3.

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