

Original Research Article

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Tray Drying Characteristics of Onion Slices and Physicochemical Analysis of Dried Onion Powder

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ABSTRACT

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The present work was aimed to study the effect of pretreatments and drying temperatures on quality and drying characteristic of onion slices in tray dryer and to study the effect of drying air temperature (1st stage drying at 70, 80, 90°C and 2nd stage at 60°C) on onion slices (2, 4, and 6mm) also examine size, pretreatments water blanching and 0.2, 0.4, 0.6 % Potassium Metabisulphite on the quality of dried onion. Result of study showed that the water blanched onion samples dried at 90°C (6mm size) took least time to get dry. Rehydration ratio was increased with increase in temperature. Potassium Metabisulphite blanched sample dried at 70°C were better in nutritional quality. Quality of onion with respect to colour, aroma and overall acceptability was better for 0.6% Potassium Metabisulphite blanched onion samples dried at 70°C

Introduction

India is one of the largest producers of the fruits and vegetables in the world with population close to 1.2 billion. Fruits and vegetables are very important for healthy living because they contain beneficial nutrients (Bates and oberts, 2001). Onion (*Allium cepa*) is widely used both for flavoring and for the potential benefits of preventing and curing ailments (Rivlin, 2001). Onion is also recommended because of its good nutritive value (Shekhad, 1996). Since ancient times, onion has been used worldwide as seasoning, spices and herbal remedies (Ahmed, 1997). Onion is known to possess a vast variety of biological functions such as antimicrobial (Kim, 2002; Krest *et al.*, 2000)

anti thrombotic (Block *et al.*, 1986), and antioxidant (Furhath, 1997; Prasad *et al.*, 1996; Siems *et al.*, 1996). Onion is a perishable crop and it cannot store safely in normal condition for a long time. Under storage, onion bulbs continuously loose water and dry matter, but more serious losses arise from, sprouting and rooting (Anonymus, Pandey, 1994). Blanching is an important heat process in the preparation of vegetables destined for canning, freezing or drying. Primarily blanching is carried out to inactivate enzymes or to destroy enzyme substrate such as peroxides. In addition to destroying enzymes, blanching also brings the changes as the raw material by destroying the bacterial load and cellular gases are expelled. To overcome the post-harvest losses of onion

the drying of onion is one of the major processing operation which reduces the volume and there by transportation cost and increases the storage life of onion. Onion powder is a spice which is made by dried onion. The spice retains some of the pungency and flavor of fresh onions. The selection of dryer should be based on the entire manufacturing process, not only for the production capacity but also for initial moisture of the product, drying characteristics of the product and maximum allowable product temperature. Drying provokes a change of the physical, chemical and biological properties and modifies the characteristics of food products (Azzous *et al.*, 2002). Therefore present investigation was undertaken to study the effect of different pretreatments (blanching with KMS and blanching with hot water) and drying temperatures (70, 80, 90⁰C) on drying behavior, nutritional and sensory quality of dried onion.

The study it has revealed that onion contains four peptides (protein components) that inhibit angiotensin I-converting enzyme-the same enzyme blocked by ACE inhibitor drugs, which are used to lower blood pressure. When given to laboratory animals bred to be hypertensive, onion produced a blood pressure lowering effect within two to four hours. Animals have to eat just 20 to 30 mg of powerful spinach peptides for each kilogram (2.2 pounds) of their body weight. In human terms, an entrée-sized onion salad for lunch or a serving of steamed onion as part of the evening meal may have a salutary effect on blood pressure two to four hours later.

In view of above consideration, study was undertaken with the following objectives,

To study the effect of pretreatments and temperature on drying characteristics of onion

slices.

To study the physicochemical characteristics of dried onion powder. To study the sensory characteristics of onion powder.

Nutritive contents of onion (per 100 g)

Energy 1.66 KJ (40 Kcal), Carbohydrate 5.1g, Sugar 4.24g, Dietary fibers 0.6g, Fat 0.1g, Water 89.11g, Calcium 19mg, Vitamin C 7.4mg, Protein 1.1g, Iron 0.21mg, Magnesium 0.129mg, Phosphorus 29mg, Potassium 120mg, and Sodium 4mg (USDA Nutrient Database, 2001).

Nutritive values of onion (per 100 g)

Moisture 89.1%, Protein 1.1g, Fat 0.1 g, Carbohydrate 5.1 g, Fiber 0.6 g and Calories 40 (USDA Nutrient Database, 2001).

Materials and Methods

The drying study of the onion powder was dried at three different temperature (70, 80 and 90⁰C) and 2nd stage drying 60⁰C after 30 minute using tray drier. There are some parameters one onion variety, four pretreatments, three different temperature and three cut of three sizes of onion slices.

Onions were cleaned, peeled, sliced and blanched. Than tray dryer was used for the drying of onion slices. After drying, the slices were grinded in grinder and sieved through 32 mesh screens and packed in LDPE bags. Use for some of the equipment's, glassware and chemicals that were employed during the course of the study are given. 1. Electronic weighing balance, 2. Slicer, 3. Tray dryer, 4. Desiccators, 5. Hot Plate and 6. Sealing Machine,

Preparation of onion powder

There are several steps are used in preparation of onion powder, raw onion, washing, peeling

(knife), slicing (2 mm, 4 mm, 6 mm), blanched with KMS solution, drying in tray drier, temp. 70, 80 and 90°C, second stage drying at 60°C, grinding, sieving (32-mesh size screen), packaging (LDPE bags), storage.

Physicochemical analysis

$$M.C. = \frac{\text{Wt. of sample at desired time} - \text{wt. of bone dry material}}{\text{Wt. of sample at any time}} \times 100 \quad \text{--- Eq. (1)}$$

Wt. of bone dried material =

$$\frac{\text{Initial wt. of the sample} \times 100 - \text{initial M.C.}}{100} \quad \text{--- Eq. (2)}$$

Dehydration ratio

Dehydration ratio was calculated by taking the weights of sample before drying and the weight of sample after drying.

$$\text{Rehydration Ratio} = \frac{WD}{WB} \quad \text{--- Eq. (3)}$$

Where, WD = weight of the onion sample after drying, g, WB = weight of the onion sample before drying, g

Rehydration ratio

The reconstitution or Rehydration ratio is one of the important bases to form a base material for further utilization. Dehydrated vegetables are rehydrated to study the reconstitution of dried sample. Rehydration ratio shows the originality gained and acceptability attribute of a product.

Procedure: 10 g samples of each were weighed. Placed in 600 ml beaker, 150 ml distilled water was added, it was covered and placed on electric heater, boiled for 25 minutes. The precise amount of water varies

Moisture content of sample

Moisture content during drying was computed through mass balance. For this purpose, weight of the sample during drying was recorded at time interval of every 30 minute.

with material, time and rate of boiling, excessive amount of water should not be used. Removed from the heater and dumped into a funnel which was covered with a coarsely pour filter paper. Applied suction and drained with careful stirring for one min. or until the drop from the funnel has almost stopped. Remove from the funnel and weighed.

Calculation was made by using following formula to express the results in terms of 'Rehydration ratio'.

$$\text{Rehydration Ratio} = \frac{\text{Wt. of reconstituted rehydrated sample (g)}}{\text{Wt. of rehydrated sample (g)}} \quad \text{--- Eq. (4)}$$

Determination of moisture content

Initial moisture content

Standardization procedures of AOAC (1990) will be followed to estimate the moisture content of food.

Procedure: 05 g of the sample was weighted and placed in a tared porcelain dish w_1 (g). Dish was placed in hot air oven maintained at $105^\circ \text{C} \pm 20$ and dried for at least two hours. Dish was cooled in desiccators and weighed. The process of heating, cooling and weighing was repeated until the difference between two successive weighing was not more than 0.002

g.

Tare weight of dish w (g).

Weight of dish with sample W₁ (g).

Weight of dish + sample after keeping in oven W₂ (g).

Observation

Calculation

Percent moisture content

$$= \frac{\text{Loss in weight}}{\text{Initial weight of the sample}} \times 100 \text{ -- Eq. (5)}$$

$$\frac{W_1 - W_2}{W_1 - W} \times 100$$

The moisture content of the sample was computed using the following equations.

- 2, 6 – dichlorophenol-indophenol dye indicator
- 3% Meta phosphoric Acid
- 6% Meta phosphoric Acid

$$\text{Moisture content (wet basis)} = \frac{M_1 - M_2}{M_1} \times 100 \text{ -- Eq. (6)}$$

$$\text{Moisture content (dry basis)} = \frac{M.C.(\text{wet basis})}{100 - M.C.(\text{wet basis})} \times 100 \text{ -- Eq. (7)}$$

$$\text{M.C. (lost)} = \text{M.C. (Current)} - \text{M.C. (Previous)}$$

$$\text{Drying rate} = (W_t - W_{t + Dt}) / (D_t * W_d) \text{ -- Eq. (8)}$$

Where,

W_t = Weight of sample at any time t, g. W_{t+Dt} = Weight of sample at any time t+Dt, g. D_t = Time interval, minute. W_d = Weight of bone dry material, g. M.C. = moisture content of sample (% w.b. and % d.b.). M.C. = moisture content of sample (% w.b. and d.b.). M₁ = wt. of sample before drying (g). M₂ = wt. of sample after drying (g).

Determination of ascorbic acid (Vitamin C)

Ascorbic acid was determined by (Ranganna, 1986).

Reagents used

Standard Ascorbic Acid

Standardization of dye solution: 05 ml of standard ascorbic acid solution was placed in a clean beaker to which 5 ml of 3 % meta-phosphoric acid solution was added with the help of pipette. This solution was titrated against the dye till a faint pink colour appeared which persisted for not more than 15 seconds. Procedure: 30 g (W₁) of dehydrated onion blended with equal weight (W₂) of 6% met phosphoric acid for 3-4 minute 15 g (W₃) of this slurry was placed in 100 ml (V₁) volumetric flask and volume was made by adding 3% met phosphoric acid. It was filtered through a fast filter paper. Burette was filled with standardized 2, 6-dichlorophenol indophenol's dye solution. 10 ml of filter solution (V₂) was taken in conical flask and immediately titrated against the standard dye solution (V) till a faint pink colour will appear and persisted for 15 second.

Calculation

Calculated the ascorbic acid content in mg/100 g of sample as follows

Ascorbic acid mg/100 =

$$\frac{W_1 + W_2}{W_1 + W_3} \times \frac{V_1}{V_2} \times 100 \left(V \times \frac{1}{r} \right) \text{ -- Eq. (9)}$$

Where,

W_1 = weight of the sample (dried).

W_2 = weight of 6% metaphosphoric acid.

W_3 = weight of the slurry transferred in ml volumetric flask.

V_1 = make up volume in volumetric flask.

V_2 = ml of dye indicator used in the titration.

T = titre value of dye with standard solution of vitamin C.

Total sugar and reducing sugar

Total sugar and reducing sugar content in the sample was estimated by Lane and Eynon method (Ranganna, 1986). The estimated was based on the principal that the invert sugar reduced the copper in the Fehling's solution to red, insoluble cuprous oxide. The sugar content in the sample was estimated by determining the volume of the known sugar solution required to completely reduce a measured volume of Fehling' solution.

Reagents

1. Fehling's solution (A): Dissolve 69.28 g of copper sulphate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) in water, dilute to 1 liter.
2. Fehling's solution (B): Dissolve 346 g of potassium sodium tartrate and 100 g NaOH in water and make up to 1 liter.
3. Methylene blue indicator: Dissolve 1 g of methylene blue in 100 ml of water.
4. 45% Neutral lead acetate solution: Dissolve 225 g of Neutral lead acetate in water and dilute to 500 ml.
5. Standard invert sugar solution: Weigh 9.5 g of AR sucrose into a 1 liter volumetric flask and add 100 ml water and 5 ml of conc. HCL. Allow to stand for 3 days at 20-25⁰C for inversion to take place and make up to mark with water. Pipette 25 ml of standard invert solution in to 100 ml volumetric flask and add 50 ml of water. Add a few drops of phenolphthalein indicator and neutralize with

20% NaOH until the solution turns pink. Acidify with 1 N HCL adding it drops wise with water.

Preparation of sample

Grind the sample and allow passing through 40-50 micron sieve. Take 50 g in a beaker and add 400 ml of water. Neutralize the solution with 1N NaOH using phenolphthalein indicator. Boil gently for 1 hour with occasional stirring. Add boiling water to maintain original level. Cool and transfer to a 500 ml volumetric flask. Make up to volume and filter through No. 4 Wattman Paper. Pipette a 100 ml aliquot in to 500 ml volumetric flask. Add 2 ml neutral lead acetate solution and about 200 ml water. Let it stand for 10 minute then precipitate the excess of lead with potassium oxalate solution. Make up to mark filter.

Procedure (reducing sugar)

- i. Pipette 10 ml mixed Fehling's solution in to each of two 250 ml conical flask.
- ii. Fill the 50 ml burette with the solution to be titrated.
- iii. Run in to the flask almost the whole volume of sugar solution required to reduce the Fehling's solution, so that 0.5 ml to 1.0 ml is required later to complete the titration.
- iv. Mix the contents of the flask, heat to boiling and boil moderately for 2 minute.
- v. Add 3 drops of methylene blue solution, taking care not to allow touching the side of flask.
- vi. Complete the titration with in 1 minute and add 2 to 3 drops of sugar solution at 5 to 10 sec intervals, until the indicator is completely discolored.
- vii. That boiling liquid assumed to be brick red color or precipitated cuprous oxide before adding the indicator.
- viii. The volume of solution required.

Procedure (total sugar)

1. Pipette 50 ml of the clarified solution in to a 250 ml conical flask.
2. Add 5 g of citric acid and 50 ml of water.
3. Boil gently for 10 minute to complete the inversion of source and then cool.
4. Transfer to a 250 ml volumetric flask and neutralize with 1 N NaOH using phenolphthalein as an indicator. Make up a volume.
5. Take an aliquot and determine the total sugar as invert sugar.

Calculation

$$\% \text{ Reducing sugar} = \frac{\text{mg of invert sugar} \times \text{Dilution} \times 100}{\text{Titre} \times \text{wt of the sample}} - - \text{Eq. (10)}$$

% Total sugar as Invert sugar =

$$\frac{\text{mg of invert sugar} \times \text{Dilution} \times 100}{\text{Titre} \times \text{wt of the sample}} - - \text{Eq. (11)}$$

Statistical analysis

The experiment was conducted by adopting completely randomized design the data recorded during the course of investigation were statistically analyzed by the 'Analysis of variance'. The significant effect of treatment was judged with the help of 'F' (variance ratio). Calculated F value was compared with the table value of F at 5% level of significance. If calculated value exceeded the table value the effect was considered to the significant. The significance of the study was tested at 5% level.

$$t = r (n-2) / (1 - \frac{1}{2} r^2)$$

$$\text{SEd} = 2\text{EMSS} / r \times t \times s$$

$$\text{CD} = \text{SEd} \times t \text{ 5\% at df}$$

Where, t= distribution of observation, r= coefficient of correlation, n= no. of observation,

SEd= standard error of difference, d.f= error of degree of freedom, CD= critical difference and MESS= error mean sum of square.

Results and Discussion

These experiments were conducted to the tray drying characteristics of onion slices at different air temperature and pretreatment combinations. Dried onion slices were ground to powder in a domestic grinder. Onion powder samples were packed in LDPE bag. Studies on quality were based on physicochemical characteristics (Moisture content, Ascorbic acid content and Sugar). The physiochemical and sensory qualities were evaluated just after preparation of onion powder. On the basis of present investigation the following conclusions could be drawn. Drying rate of onion in Tray dryer was affected by hot air temperature. Higher drying rate at initial stage of drying decreases with time suggests decrease in moisture content with the passage of time.

The least final moisture content % (w.b.) was found for water blanching at 90⁰C for 6 mm, size (12.17) and maximum final moisture content % (w.b.) was found for 0.2% KMS blanched 70⁰C for 6 mm, size (35.67). The drying rate of onion slices under tray drying decreased as the drying time progressed and finally attained zero drying rates. Low the dehydration ratio betters the process of drying. It is clear that 0.2% KMS blanched sample dried at 90⁰C (6mm size) had the lowest dehydration ratio (0.105). Dehydration ratio for 0.2% KMS blanched sample dried at 70⁰C (6mm size) had the highest dehydration ratio (0.157). Higher the dehydration ratio better was the quality of the product. Dehydration ratio refers to the extent of originality in product reached after the rehydration of dehydrated product. It is clear that 0.6% KMS blanched sample dried at 90⁰C (2mm size) had the highest rehydration

ratio (5.71). Rehydration ratio for water blanched sample dried at 70⁰C (6mm size) had the lowest rehydration ratio (4.03). The final vitamin C content in water blanched Sample was lower than the KMS blanched sample. In most of the cases ascorbic acid decreased with increasing temperature and time. Maximum ascorbic acid found 8.7, 70⁰C (6mm size) 0.6% KMS and minimum ascorbic acid was 6.01, 90⁰C (2mm size) water blanching. Hence KMS treated sample showed a significant retention of vitamin C in the product. The final sugar content in water blanched Sample was lower than the KMS blanched sample. Maximum reducing sugar was 2.29, 70⁰C (6mm size) 0.6% KMS and minimum reducing sugar was 2.04, 90⁰C (2mm size) water blanching. Total score obtained for Overall acceptability evaluation on the basis of sensory evaluation was higher in drying of onion sample 0.4% KMS pretreatment and the sample dried at 70⁰C (4mm size) and maximum texture score was (7.39).

Tray drying characteristics

Onion slices were dried in tray dryer at air temperature first stage 70, 80, 90⁰C and 2nd stage drying 60⁰C to final equilibrium moisture content. The initial moisture content of onion slices was found to be 89.90% (w.b.) for each sample. The relationship between moisture content, drying time is shown in figure 1 to 2.

Drying characteristics of water blanched onion sample (2 mm size): The water blanched onion sample dried at 70⁰C air temperature, moisture content reduced to 22.23% (w.b.) at the end of 360 minute drying, for the same pretreatment and size, the moisture content at 80⁰C temperature moisture content was reduced to 14.04% (w.b.) at the end of 330 minute drying and 90⁰C temperature moisture content reduced to

18.88% (w.b.) at the end of 300 minute drying. As shown in figure 1.

Drying characteristics of 0.2% KMS blanched onion sample (2 mm size): The 0.2% KMS blanched onion sample dried at 70⁰C air temperature, moisture content reduced to 28.86% (w.b.) at the end of 360 minute drying, for the same pretreatment and size, the moisture content at 80⁰C temperature moisture content reduced to 30.28% (w.b.) at the end of 330 minute drying and 90⁰C temperature moisture content reduced to 26.18% (w.b.) at the end of 300 minute drying. As shown in figure 2.

Drying characteristics of 0.4% blanched onion sample (2 mm size): The 0.4% blanched onion sample dried at 70⁰C air temperature, moisture content reduced to 22.60% (w.b.) at the end of 360 minute drying, for the same pretreatment and size, the moisture content at 80⁰C temperature moisture content reduced to 22.31% (w.b.) at the end of 330 minute drying and 90⁰C temperature moisture content reduced to 16.18% (w.b.) at the end of 300 minute drying. As shown in figure 3.

Drying characteristics of 0.6 % blanched onion sample (2 mm size): The 0.6% blanched onion sample dried at 70⁰C air temperature, moisture content reduced to 31.99 % (w.b.) at the end of 360 minute drying, for the same pretreatment and size, the moisture content at 80⁰C temperature moisture content was reduced to 30.58% (w.b.) at the end of 330 minute drying and 90⁰C temperature moisture content reduced to 12.93 % (w.b.) at the end of 300 minute drying. As shown in figure 4.

Drying characteristics of water blanched onion sample (4 mm size): The initial moisture content of the onion slices was 89.90% (w.b.). As shown in figure 5. For

water blanched onion sample dried at 70⁰C air temperature, moisture content reduced to 13.68% (w.b.) at the end of 360 minute drying, for the same pretreatment and size, the moisture content at 80⁰C temperature moisture content reduced to 20.78% (w.b.) at the end of 330 minute drying and 90⁰C temperature moisture content reduced to 25.74% (w.b.) at the end of 300 minute drying.

Drying characteristics of 0.2% KMS blanched onion sample (4 mm size): The initial moisture content of the onion slices was 89.90% (w.b.). As shown in figure 6. For 0.2% KMS blanched onion sample dried at 70⁰C air temperature, moisture content reduced to 30.58% (w.b.) at the end of 360 minute drying, for the same pretreatment and size, the moisture content at 80⁰C temperature moisture content reduced to 32.21% (w.b.) at the end of 330 minute drying and 90⁰C temperature moisture content reduced to 27.34% (w.b.) at the end of 300 minute drying.

Drying characteristics of 0.4% KMS blanched onion sample (4 mm size): The initial moisture content of the onion slices was 89.90% (w.b.). As shown in figure 7. For 0.4% KMS blanched onion sample dried at 70⁰C air temperature, moisture content reduced to 26.01% (w.b.) at the end of 360 minute drying, for the same pretreatment and size, the moisture content at 80⁰C temperature moisture content reduced to 30.58% (w.b.) at the end of 330 minute drying and 90⁰C temperature moisture content reduced to 17.89% (w.b.) at the end of 300 minute drying.

Drying characteristics of 0.6% KMS blanched onion sample (4mm size): The initial moisture content of the onion slices was 89.90% (w.b.). As shown in figure 8. For 0.6% KMS blanched onion sample dried at 70⁰C air

temperature, moisture content reduced to 33.77% (w.b.) at the end of 360 minute drying, for the same pretreatment and size, the moisture content at 80⁰C temperature moisture content reduced to 31.29% (w.b.) at the end of 330 minute drying and 90⁰C temperature moisture content reduced to 16.53% (w.b.) at the end of 300 minute drying.

Drying characteristics of water blanched onion sample (6 mm size): The initial moisture content of the onion slices was 89.90% (w.b.). As shown in figure 9. For water blanched onion sample dried at 70⁰C air temperature, moisture content reduced to 16.87% (w.b.) at the end of 360 minute drying, for the same pretreatment and size, the moisture content at 80⁰C temperature moisture content reduced to 22.61% (w.b.) at the end of 330 minute drying and 90⁰C temperature moisture content reduced to 12.17% (w.b.) at the end of 300 minute drying.

Drying characteristics of 0.2% KMS blanched onion sample (6 mm size): The initial moisture content of the onion slices was 89.90% (w.b.). As shown in figure 10. For 0.2% KMS blanched onion sample dried at 70⁰C air temperature, moisture content reduced to 35.67% (w.b.) at the end of 360 minute drying, for the same pretreatment and size, the moisture content at 80⁰C temperature moisture content reduced to 33.77% (w.b.) at the end of 330 minute drying and 90⁰c temperature moisture content reduced to 28.11% (w.b.) at the end of 300 minute drying.

Drying characteristics of 0.4% KMS blanched onion sample (6 mm size): The initial moisture content of the onion slices was 89.90% (w.b.). As shown in figure 11. For 0.4% KMS blanched onion sample dried at 70⁰C air temperature, moisture content

reduced to 30.10% (w.b.) at the end of 360 minute drying, for the same pretreatment and size, the moisture content at 80⁰C temperature moisture content reduced to 31.29% (w.b.) at the end of 330 minute drying and 90⁰c temperature moisture content reduced to 25.19% (w.b.) at the end of 300 minute drying.

Drying characteristics of 0.6% KMS blanched onion sample (6 mm size): The initial moisture content of the onion slices was 89.90% (w.b.).

As shown in figure 12 For 0.6% KMS blanched onion sample dried at 70⁰C air temperature, moisture content reduced to 34.63% (w.b.) at the end of 360 minute drying, for the same pretreatment and size, the moisture content at 80⁰C temperature moisture content reduced to 32.44% (w.b.) at the end of 330 minute drying and 90⁰c temperature moisture content reduced to 24.06% (w.b.) at the end of 300 minute drying.

Effect of temperature and pretreatments on dehydration ratio

The rehydration ratio is one of the important parameter showing the bulk reduction in the weight of the onion. High the rehydration ratios better the process of drying. Rehydration ratio refers to the extent of originality in product. From (Fig. 13) it is clear that 0.2% KMS blanched sample dried at 90⁰C (6mm size) has the lowest rehydration ratio (0.105).

Rehydration ratio for .2% KMS blanched sample dried at 70⁰C (6mm size) has the highest rehydration ratio (0.157). Singh *et al.* (2006) carried out a study on effect of drying conditions on the quality of dehydrated leafy vegetables (amaranth, curry leaves, drumstick leaves, *methi* and *palak*) reported that the rehydration ratio was lower in the product

rehydrated at high temperature and it was comparatively high in the products dried at low temperature (Fig. 14 and 15).

Rehydration ratio refers to the extent of originality in product reached after the rehydration of Rehydrated product. From (Fig. 16) it is obvious that 0.6% KMS blanched sample dried at 90⁰C (2 mm size) has the highest rehydration ratio (5.71). Rehydration ratio for water blanched sample dried at 70⁰C (6 mm size) had the lowest rehydration ratio (4.03).

The least rehydration ratio was observed for the sample without blanching. Singh *et al.* (2006) conducted a study on effect of drying conditions on the quality of rehydrated leafy vegetables (amaranth, curry leaves, drumstick leaves, *methi* and *palak*) and reported that the rehydration ratio was higher in the product rehydrated at high temperature and it was comparatively low in the products dried at low temperature. The statistically analyzed data is tabulated in Appendix A and B (Fig. 17 and 18).

Effect of temperature and pretreatment on the Ascorbic acid (Vitamin C)

The final vitamin C content in water blanch Sample is lower than the KMS blanched sample according to figure 19. In most of the cases ascorbic acid decreased with increasing temperature and time. Similar results were reported by Yadav and Sehgal (1997).

Maximum ascorbic acid found was 8.71 70⁰C (6mm size) 0.6% KMS and minimum ascorbic acid 6.01 90⁰C (2mm size) water blanching (Fig. 19).

The vitamin C content in water blanch sample (2mm size) was 8.01, 7.21, 6.01 and (4mm size) 8.08, 7.39, 6.72 and (6mm size) 8.15, 7.46, 6.89 mg/100g at temperature 70, 80, and 90⁰C.

Annexure-A: Effect of tray drying on dehydration ratio of onion sample at different Pretreatments and temperature (2mm, 4mm, 6mm size)

Pretreatments	Size of onion sample (mm)	Temperature (⁰ C)		
		70 ⁰ C	80 ⁰ C	90 ⁰ C
Water Blanching	2	0.140	0.117	0.124
	4	0.117	0.127	0.136
	6	0.121	0.130	0.133
0.2% KMS	2	0.114	0.146	0.120
	4	0.145	0.149	0.133
	6	0.157	0.152	0.105
0.4% KMS	2	0.130	0.130	0.120
	4	0.136	0.145	0.123
	6	0.144	0.147	0.135
0.6% KMS	2	0.148	0.145	0.116
	4	0.152	0.147	0.121
	6	0.154	0.149	0.133

Annexure-B: Effect of tray drying on Rehydration ratio of onion sample at different Pretreatments and temperature (2mm, 4mm, 6mm size)

Pretreatments	Size of onion sample (mm)	Temperature (⁰ C)		
		70 ⁰ C	80 ⁰ C	90 ⁰ C
Water Blanching	2	4.11	4.21	4.35
	4	4.08	4.19	4.30
	6	4.03	4.14	4.21
0.2% KMS	2	4.66	4.99	5.01
	4	4.42	4.91	4.99
	6	4.31	4.72	4.89
0.4% KMS	2	5.02	5.30	5.45
	4	5.19	5.22	5.32
	6	5.16	5.19	5.23
0.6% KMS	2	5.31	5.54	5.71
	4	5.27	5.47	5.62
	6	5.21	5.32	5.44

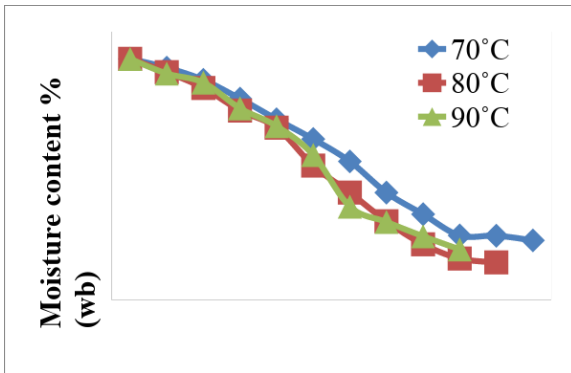


Fig.1 Effect of tray drying on moisture content of water blanching onion sample (2mm size) dried at different temperature

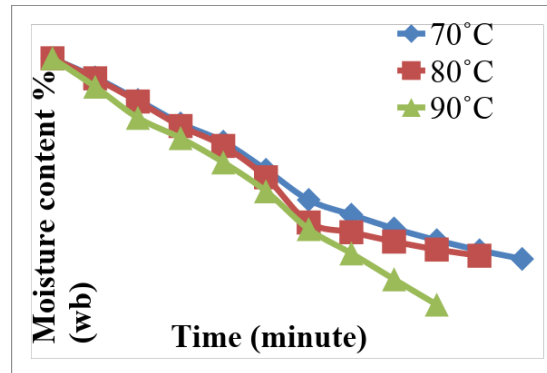


Fig.2 Effect of tray drying on moisture content of 0.2 % KMS blanching onion sample (2mm size) dried at different temperature

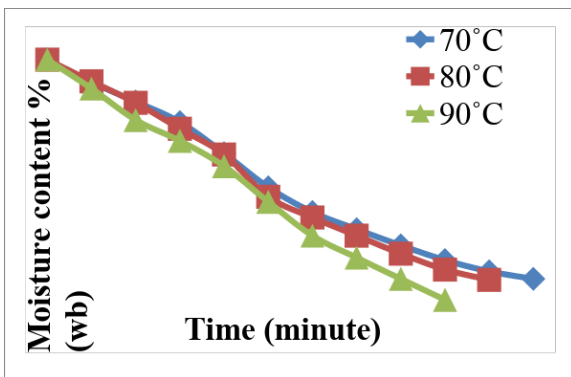


Fig.3 Effect of tray drying on moisture content of 0.4 % KMS blanching onion sample (2mm size) dried at different temperature

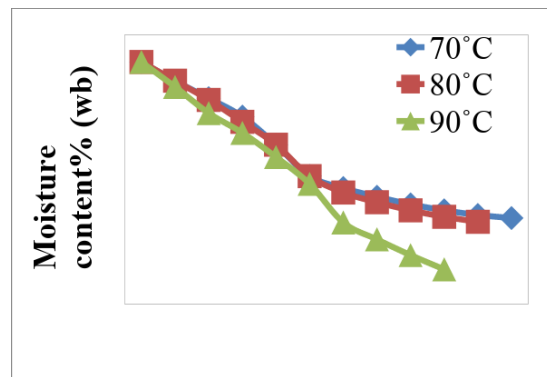


Fig.4 Effect of tray drying on moisture content of 0.6 % KMS blanching onion sample (2mm size) dried at different temperature

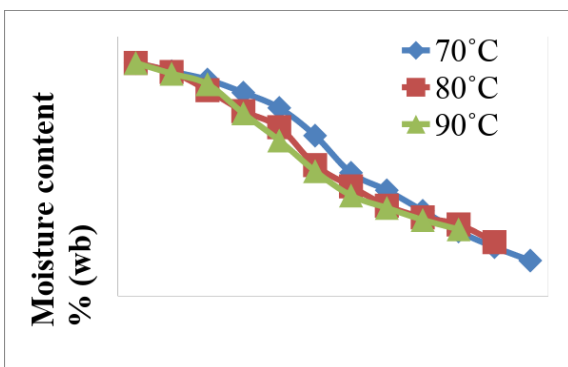


Fig.5 Effect of tray drying on moisture content of water blanching onion sample (4 mm size) dried at different temperature

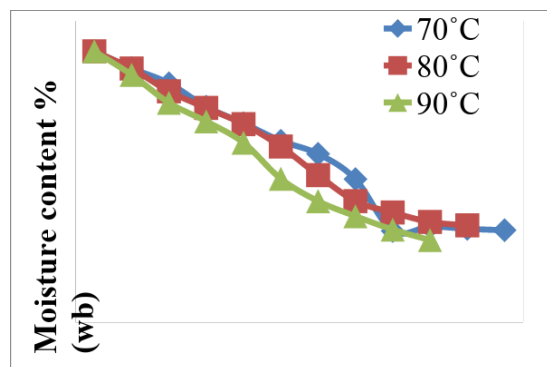


Fig.6 Effect of tray drying on moisture content of 0.2% KMS blanching onion sample (4 mm size) dried at different temperature.

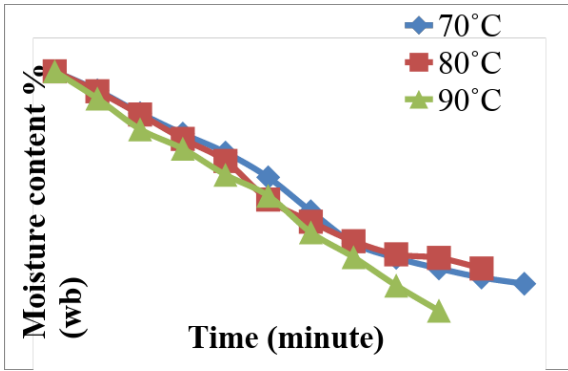


Fig.7 Effect of tray drying on moisture content of 0.4% KMS blanched onion sample (4 mm size) dried at different temperature

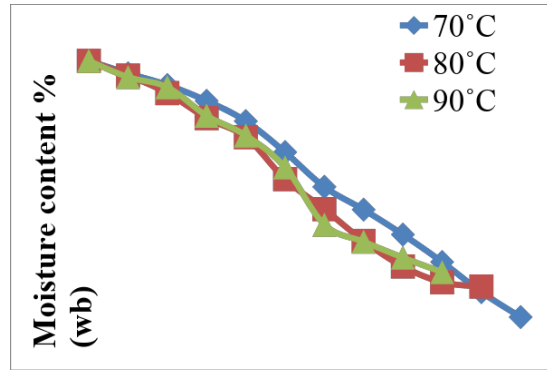


Fig.8 Effect of tray drying on moisture content of 0.6% KMS blanched onion sample (4 mm size) dried at different temperature

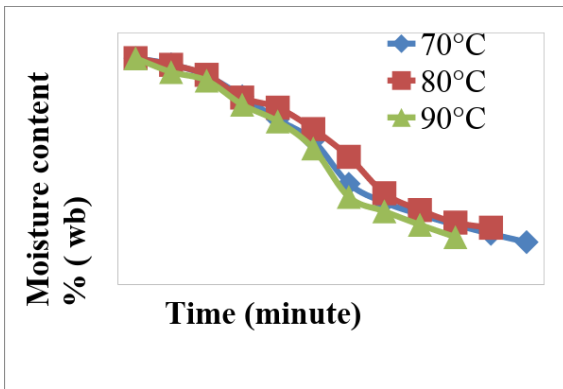


Fig.9 Effect of tray drying on moisture content of water blanched onion sample (6 mm size) dried at different temperature

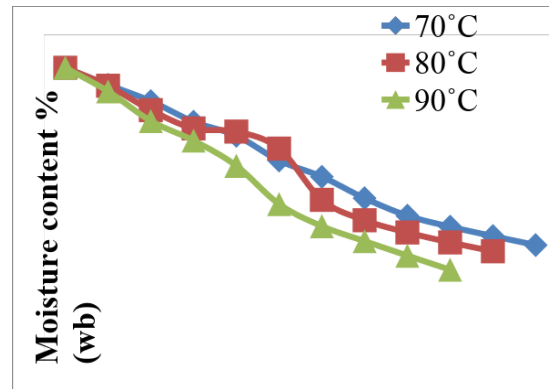


Fig.10 Effect of tray drying on moisture content of 0.2% KMS blanched onion sample (6 mm size) dried at different temperature

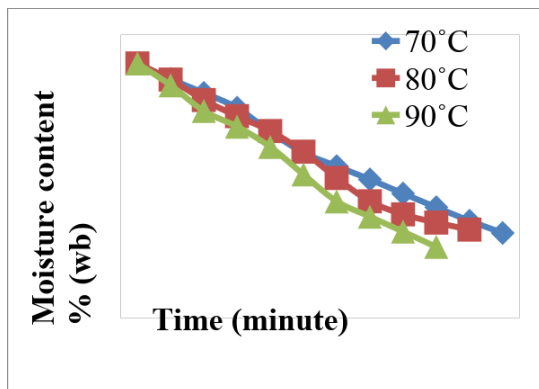


Fig.11 Effect of tray drying on moisture content of 0.4% KMS blanched onion sample (6 mm size) dried at different temperature

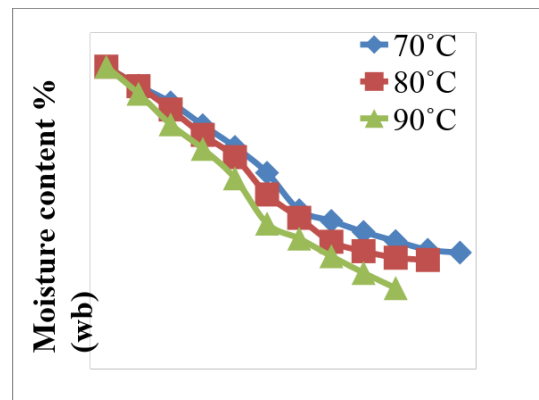


Fig.12 Effect of tray drying on moisture content of 0.6% KMS blanched onion sample (6 mm size) dried at different temperature

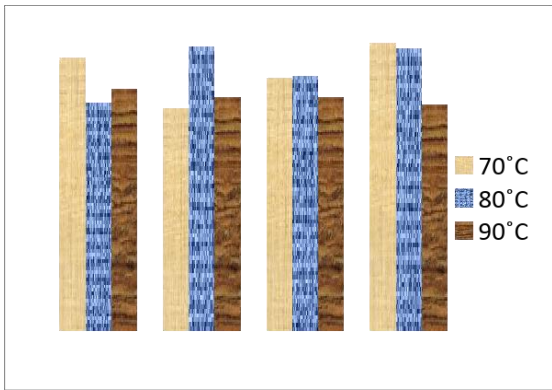


Fig.13 Effect of tray drying on rehydration ratio of onion sample (2mm size) at different pretreatments and drying temperature

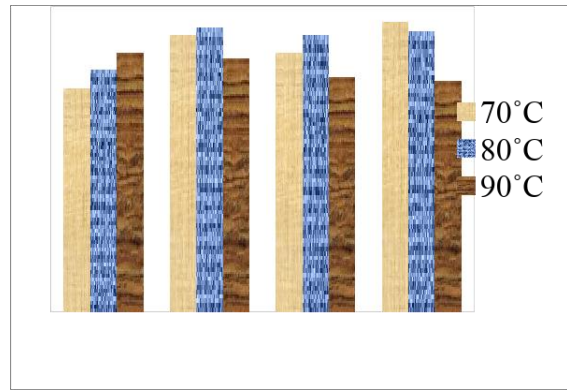


Fig.14 Effect of tray drying on rehydration ratio of onion sample (4mm size) at different pretreatments and drying temperature

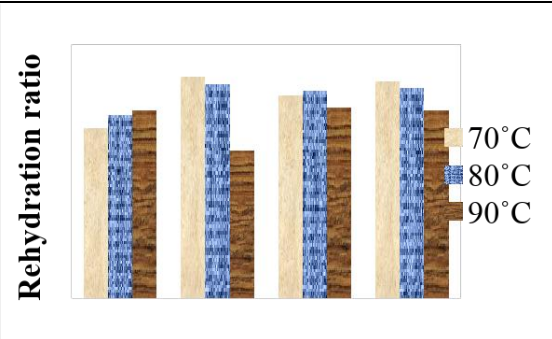


Fig.15 Effect of tray drying on rehydration ratio of onion sample (6 mm size) at different pretreatments and drying temperature

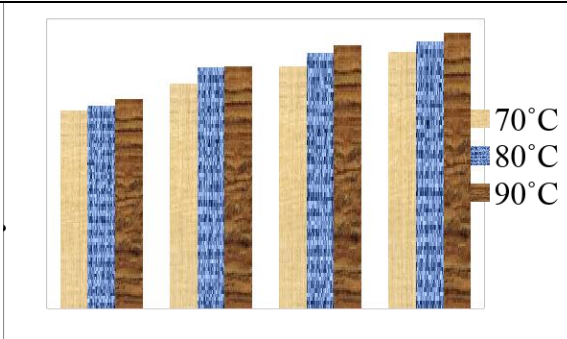


Fig.16 Effect of tray drying on rehydration ratio of onion sample (2 mm size) at different pretreatments and drying temperature

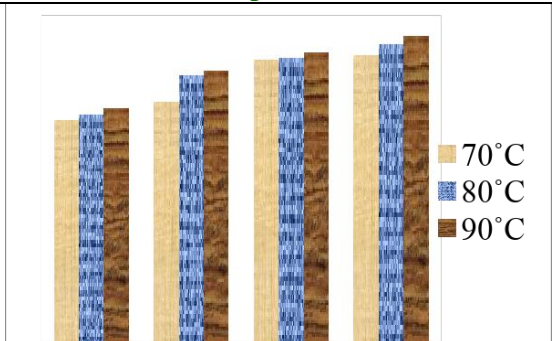


Fig.17 Effect of tray drying on rehydration ratio of onion sample (4 mm size) at different pretreatments and drying temperature

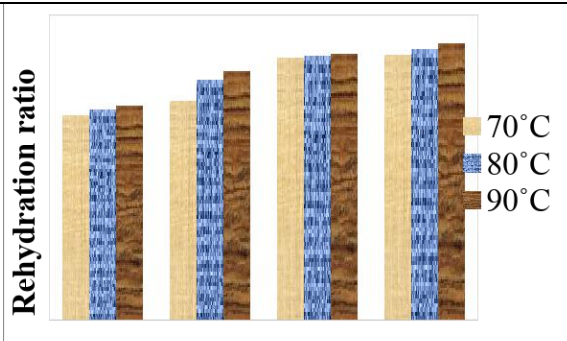


Fig.18 Effect of tray drying on rehydration ratio of onion sample (6 mm size) at different pretreatments and drying temperature

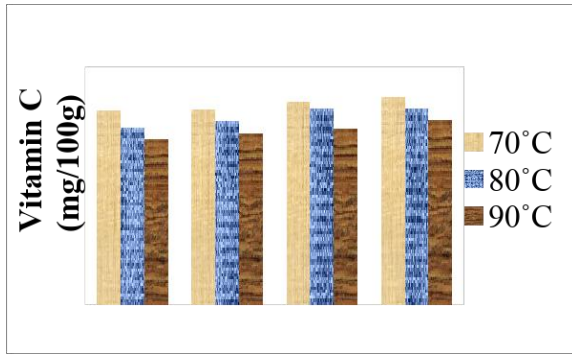


Fig.19 Effect of tray drying on vitamin C content of onion sample (6mm size) at different pretreatments and drying temperature

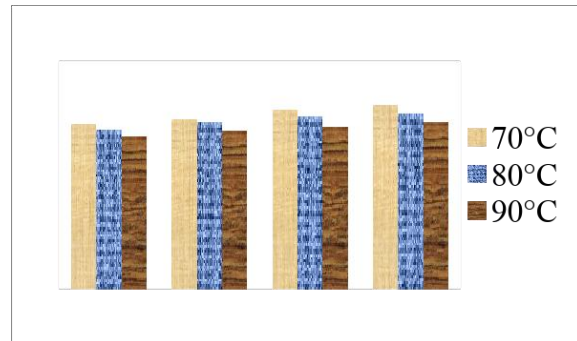


Fig.20 Effect of tray drying on sugar content of onion sample (6mm size) at different pretreatment and drying temperature

The vitamin C content in 0.2%KMS sample (2mm size) was 8.09, 7.5, 6.95 and (4mm size) 8.11, 7.65, 7.1 and (6mm size) 8.19, 7.74, 7.2 mg/100g at temperature 70, 80, and 90°C.

The vitamin C content in 0.4%KMS sample (2mm size) was 8.31, 7.92, 7.14 and (4mm size) 8.42, 8.15, 7.29 and (6mm size) 8.53, 8.24, 7.4 mg/100g at temperature 70, 80, and 90°C.

The vitamin C content in 0.6%KMS sample (2mm size) was 8.56, 8.03, 7.55 and (4mm size) 8.62, 8.11, 7.69 and (6mm size) 8.71, 8.23, 7.76 mg/100g at temperature 70, 80, and 90°C.

Effect of temperature and pretreatment on the sugar

The final sugar content in water blanched sample was lower than the KMS blanched sample according to figure 20. In most of the cases sugar content decreased with increase in temperature and time. Same results were also reported by Yadav and Sehgal (1997) (Fig. 20).

Maximum reducing sugar was 2.29 70°C (6mm size) 0.6% KMS and minimum reducing sugar was 2.04 90°C (2 mm size) in water blanching. The reducing sugar content found in water blanched sample (2mm size) was 2.11, 2.08, 2.04 and (4mm size) 2.13, 2.11, 2.06 and (6mm size) 2.16, 2.12, 2.07 mg/100g at temperature 70, 80, and 90°C.

The reducing sugar content found in 0.2%KMS sample (2mm size) was 2.14, 2.12, 2.09 and (4mm size) 2.16, 2.14, 2.1 and (6mm size) 2.19, 2.17, 2.11 mg/100g at temperature 70, 80, and 90°C

The reducing sugar content in 0.4%KMS sample (2mm size) was 2.17, 2.14, 2.11 and (4mm size) 2.23, 2.19, 2.13 and (6mm size) 2.26, 2.23, 2.14 mg/100g at temperature 70, 80, and 90°C.

The reducing sugar content in 0.6%KMS sample (2mm size) was 2.23, 2.18, 2.13 and for 4 mm size it was 2.25, 2.21, 2.15 and for 6mm size it was 2.29, 2.23, 2.17 mg/100g at temperature 70, 80, and 90°C.

Sensory evaluation

Sensory attributes are one of the most important attributes of foods both for its aesthetic value and quality judgment, and it may easily change if not properly protected, some important parameters like colour, texture, taste, flavour and over all acceptability play an important role in quality judgment of any food material. Bajaj *et al.*, (1993) evaluated culinary quality of blanched and rehydrated fenugreek leaves. Color, texture and overall quality of blanched leaves received significantly higher scores than unblanched leaves.

Overall acceptability

The overall acceptability score for all the pretreatments at three temperatures. It was observed that drying with KMS blanching pretreatment is most efficient than other pretreatments for the retention of Overall acceptability of dried onion sample. Total score obtained for Overall acceptability on the basis of sensory evaluation was found higher in drying of onion sample 0.4% KMS pretreatment and the sample dried at 70⁰C (4mm size) and maximum texture score (7.39).

In conclusion, experiments were conducted to study the tray drying characteristics of Onion slices and preparation of onion powder. Studies were also carried out to investigate the effect of treatment on drying characteristics of onion slices and quality parameters of onion powder just after preparation and storage. Fresh onion was procured from local market. Onion were cleaned, washed, peeled, sliced and blanched with KMS solution. After blanching the onion slices were dried in tray dryer at different temperature. After drying, the slices were grind in grinder and sieved through Mesh screen and packed in LPDE bags. The physiochemical and sensory qualities were evaluated just after preparation of onion powder. On the basis of present investigation the following conclusions could be drawn.

Drying rate of onion in tray dryer was affected by hot air temperature.

Higher drying rate at initial stage of drying decreases with time suggests decrease in moisture content with the passage of time.

The least final moisture content % (w.b.) was found for water blanching (12.17) at 90⁰C for 2mm size and maximum final moisture content % (w.b.) was found for 0.2% KMS blanched 70⁰C 6mm size (35.67).

The drying rate of onion slices under tray drying decreased as the drying time progressed and finally attained zero drying rates.

Low the rehydration ratio betters the process of drying. It is clear that 0.2% KMS blanched sample dried at 90⁰C (6mm size) has the lowest

rehydration ratio (0.105). Rehydration ratio for 0.2% KMS blanched sample dried at 70⁰C (6mm size) has the highest rehydration ratio (0.157).

Higher the rehydration ratio better is the quality of the product. Rehydration ratio refers to the extent of originality in product reached after the rehydration of rehydrated product. It is clear that 0.6% KMS blanched sample dried at 90⁰C (2mm size) has the highest rehydration ratio (5.71). Rehydration ratio for water blanched sample dried at 70⁰C (6mm size) has the lowest rehydration ratio (4.03).

The final vitamin C content in water blanched Sample is lower than the KMS blanched sample. In most of the cases ascorbic acid decreases with increasing temperature and time. Maximum ascorbic acid found 8.71 70⁰C (6mm size) 0.6% KMS and minimum ascorbic acid found 6.01 90⁰C (2mm size) water blanching.

The final sugar content in water blanched Sample is lower than the KMS blanched sample. In most of the cases sugar decreases with increasing temperature and time. Maximum reducing sugar found 2.29 70⁰C (6mm size) 0.6% KMS and minimum reducing sugar found 2.04 90⁰C (2mm size) water blanching.

Total score obtained for Overall acceptability evaluation on the basis of sensory evaluation was found higher in drying of onion sample 0.4% KMS pretreatment and the sample dried at 70⁰C (4mm size) Maximum OA score (7.39).

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