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Effect of pre-treatments on drying characteristics of Potato (*Solanum tuberosum*) Slices

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Abstract
Potato plays an important role in world food security. It is a versatile and carbohydrate rich food which contains about 80% water and 20% dry matter content. It is low in fat content but rich in several micronutrients, especially vitamin C. The pre-treatments on fruit and vegetables before drying in one form or other *viz*., washing in water, blanching, KMS, sugar, salt either alone in combination inhibit enzymatic browning, enhancing color, flavour and texture retention. The present studies were carried out to determine the effect of pretreatments *viz*. brine solution, KMS solution, KMS plus blanching, blanching on drying characteristics of potato slices (Kufri Chipsona-1, Kufri Jyoti and Kufri Bahar). It was observed that sample pretreated with brine solution took higher drying time to achieve the final moisture content as compared to other pretreated samples. The KMS treated slices were achieved higher value of drying rate and brine treated slices were achieved lowest drying rate. It was observed that potato slices did not have any constant rate period and the entire drying took place in falling rate period. It was also observed that drying rate was higher in the initial period of drying and subsequently reduced with decrease in moisture content. The drying rate of potato slices dipped in brine solution was slower than blanched samples due to the presence of salt in solution which inhibits the rate of water transfer from potato slices. The result revealed that moisture content and drying rate depends on potato varieties and pretreatment.

Keywords: Potato, drying rate, pretreatments, moisture content and time

Introduction

The potato (*Solanum tuberosum*) is the fourth most important agricultural crop grown for human consumption after rice, wheat, and corn (USDA Economic Research Service 2014) [13]. It is the most important tuber crop in the world. It belongs to family Solanaceae and plays a role in world food security as it is a cheap and plentiful crop. Two main subspecies of potatoes exist, S. tuberosum: andigena, known as Andean and S. tuberosum, or Chilean (Zaheer and Akhtar, 2014) [14]. S. tuberosum varieties remain the most commonly grown and consumed representing ~10% of cultivated species and over 200 wild species (FAO, 2008) [5]. Tremendous variation in physical (size, shape and color), organoleptic, and nutritional quality exists in potatoes. India ranks 3rd in area and 2nd in production in the world after China. At world level, about 368.247 million tonnes of potato is produced. This production is obtained over an area of about 17.580 million hectare. The major potato growing countries in the world are China, Russia, India, USA, Germany, Poland, Ukraine, U.K., Turkey, Iran, Netherlands, France, New Zealand and Belgium (FAO 2018) [6]. Potato is a versatile, carbohydrate-rich food. When freshly harvested, it contains about 80 percent water and 20 percent dry matter content. About 60 to 80 percent of the dry matter is starch. On a dry weight basis, potato protein content is similar to cereals but very high when compared with other root and tuber crops. It is low in fat content (0.1%) but rich in several micronutrients, especially vitamin C. Potato is a moderate source of iron, and its high vitamin C content promotes iron absorption. It is a good source of vitamins like Vitamin B1, B3 and B6 and minerals such as potassium, phosphorus and magnesium. Potatoes also contain dietary antioxidants, which play a part in preventing diseases related to ageing, and dietary fibre, which benefits health (Marwaha 1987) [7].

In India, 47 potato varieties have been bred for different agro-climatic region in which 28 varieties alone for north Indian plains. From the 47 varieties developed, 19 possess multiple resistances to different biotoc and abiotic stresses. Besides, nine varieties are suitable for processing purposes.

These are Kufri Chipsona- 1, Kufri Chipsona- 2, Kufri Chipsona- 3, Kufri Himsona, Kufri Jyoti, Kufri Frysona, Kufri Chandramukhi, Kufri Lauvkar and Kufri Surya. Kufri Chipsona- 1 and Kufri Chipsona- 3 are now being used for the industries for processing into chips and French fries (CPRI, Shimla 2019) [3]. About 68% of potatoes are utilized for table purpose, 7.5 % for processing, 8.5% for seed and remaining 16% produce goes waste due to pre and post harvest handling (National Horticultural Research and Development Foundation, 2019) [8]. The pre-treatments on fruit and vegetables before drying in one form or other *viz*., washing in water, blanching, KMS, sugar, salt either alone in combination inhibit enzymatic browning, enhancing color, flavour and texture retention (Singh *et al.*, 2008) [12]. Pre-treatment increased the drying rate probably due to softer and looser structure of pretreated sample, which facilitate the removal of moisture during drying (Doymaz 2013) [4].

Processing of potato is very advantageous because it makes storage easier due to the reduction in bulkiness and increased in shelf life. It adds value to potatoes and therefore gives better returns. Processed products have an attractive color, acceptable texture and good flavour. Potatoes are processed into many type of product such as fried dehydrated product, frozen products such as French fries and patties, puff, dice, canned products such as chips/wafers etc in which potato chips are very popular and highly consumed product.

Materials

Three varieties of potatoes namely Kufri Chipsona-1, Kufri Jyoti and Kufri Bahar were procured from the experimental farm of Central Potato Research Institute (CPRI), Modipuram for the present studies.

Sample preparation

Potatoes were washed with fresh water to remove the adhering soil particles and peeled manually with the help of stainless steel peeler. Peeled potatoes were cut into slices of 2 mm thickness using hand operated stainless steel slicer. Then potato slices were pre-treated with different method such as dipped in 5% brine solution for 6 hours (T_1), 0.5 % potassium meta bisulphite (KMS) for 15 minutes (T_2), blanching with 0.5 % potassium meta bisulphite (KMS) for 3 minutes (T_3), hot water blanching for 3 minutes (T_4) and control (T_0). After pre-treatments, slices were spread over the blotting paper to remove surface moisture for drying experiments.

Drying of potato slices

The drying was conducted at 60^o C temperatures. Initially, the tray dryer was run idle for about 30 minutes to stabilize the desired temperature. Once the temperature got stabilized, the slices (500 g each samples) were spread uniformly over the drying trays in a single layer and placed in the drying chamber. Then, at pre-determined time interval of 60 minutes, samples were quickly taken out of the dryer, weighted and placed again into the dryer for further drying. An electronic balance was used for weighing of samples. The drying process was continued till constant weight of the samples achieved. The corresponding moisture content of the samples was computed through mass balance. At the end of drying, samples were cooled at room temperature and ground to make potato flour for further studies.

Drying characteristics of Potato slices

Initial moisture content

Initial moisture content of potato slices were determined by hot air oven method recommended by Ranganna (2001) [10].

$$\text{IMC} = \frac{M_1 - M_2}{M_0} \times 100$$

Where,

IMC = Initial moisture content of sample, % (w.b.)

M_0 = Initial weight of sample taken, 5g

M_1 = Weight of sample before oven drying plus weight of dish with cover, g

M_2 = Weight of dried and desiccated sample plus weight of dish with cover, g

Drying rate analysis

Drying rate was calculated using following equation

$$R = \frac{(W_t - W_{t+dt})}{(D_t \times W_d)}$$

Where,

R= Drying rate, g of water removed/min/g of bone dry matter

W_t = Weight of sample at any time‘t’ during the experiment,g

$W_{t\ +Dt}$ = Weight of sample at any time‘t+Dt’ during the experiment, g

D_t = Time interval, min

W_d = Weight of bone dry matter, g

Weight of bone dry materials were calculated as

$$W_d = W_i \left(\frac{100 - mc'}{100}\right)$$

Where,

W_i = Initial weight of sample, g

mc' = Moisture content of the sample, g

Results and discussion

Moisture content

The initial moisture content of different cultivars of potatoes was obtained as 350.45, 400, and 455.55% on dry basis for Kufri chipsona-1, Kufri Jyoti and Kufri Bahar, respectively. The dry matter were observed as 22.2% (Kufri chipsona-1), 20% (Kufri Jyoti) and 18% (Kufri Bahar). It is therefore, explicit that Kufri chipsona had highest dry matter content followed by Kufri Jyoti and Kufri Bahar.

Drying characteristics of potato slices

The variations in moisture content of potato slices with drying time are graphically represented from Fig. 1to 3 for five treatments (i.e. T_0, T_1, T_2, T_3, and T_4). The moisture content of potato slices decreased with increase in drying time for all treatment (i.e. T_0, T_1, T_2, T_3 and T_4). The potato slices of Kufri Chipsona-1 shows higher moisture content of 25.22% (db) required drying time of 600 min in T_1 (Brine solution samples) whereas lower moisture content of 1.80% (db) required drying time of 480 min in T_4 (Blanched samples). The final moisture content of samples were recorded as 1.80, 3.60, 4.50, 5.40 and 25.22% (d.b) for the slices pretreated with blanching, KMS plus blanching, control, KMS solution and brine solution respectively. The total drying time required to obtain final moisture content of different pretreated samples were from 420 to 600 min. The potato slices of Kufri Jyoti shows higher moisture content of 21% (db) required drying time of 600 min in treatment T_1 (Brine solution samples) whereas lower moisture content of 3% (db) required drying time of 540 min in T_4 (Blanched samples). The final moisture content of samples were recorded as 3.0, 5.0, 4.0, 6.0 and 21 % (db) for the slices pretreated with blanching, KMS plus blanching, control, KMS solution and brine solution respectively. The total drying time required to obtain final moisture content of different pretreated samples were from 480 to 600 min. It was noticed that during initial stage of drying process higher amount of water evaporated from the potato slices which subsequently decreased with further increased in drying times. The potato slices of Kufri Bahar shows higher moisture content of 38.88% (db) required drying time of 540 min in treatment T_1 (Brine solution samples) whereas lower moisture content of 6.66% (db) required drying time of 420 min in T_4 (Blanched samples). The final moisture content of samples were recorded as 6.6, 8.8, 10, 17.7 and 38.8 % (db) for the slices pretreated with blanching, KMS plus blanching, KMS solution, control and brine solution respectively. The total drying time required to obtain final moisture content of different pretreated samples were from 360 to 540 min. The decrease in moisture content in the treatment T_1 (brine solution) was slower than T_4 (blanching) due to salt inhibiting the release of water from the potato slices. Water is tightly bound to salt taking longer duration to evaporate. Potato slices treated with blanching alone, had the higher moisture content during initial stage of drying compared to untreated samples. It was observed that the moisture content of blanched pretreated potato slices was lower than untreated potato slices. This was probably due to softer and looser structure of the pretreated samples, which could facilitate the removal of moisture during drying (Chantaro *et al*., 2008 [2]; Nilnakara *et al*., 2009 [9]; Doymaz, 2013 [4]).

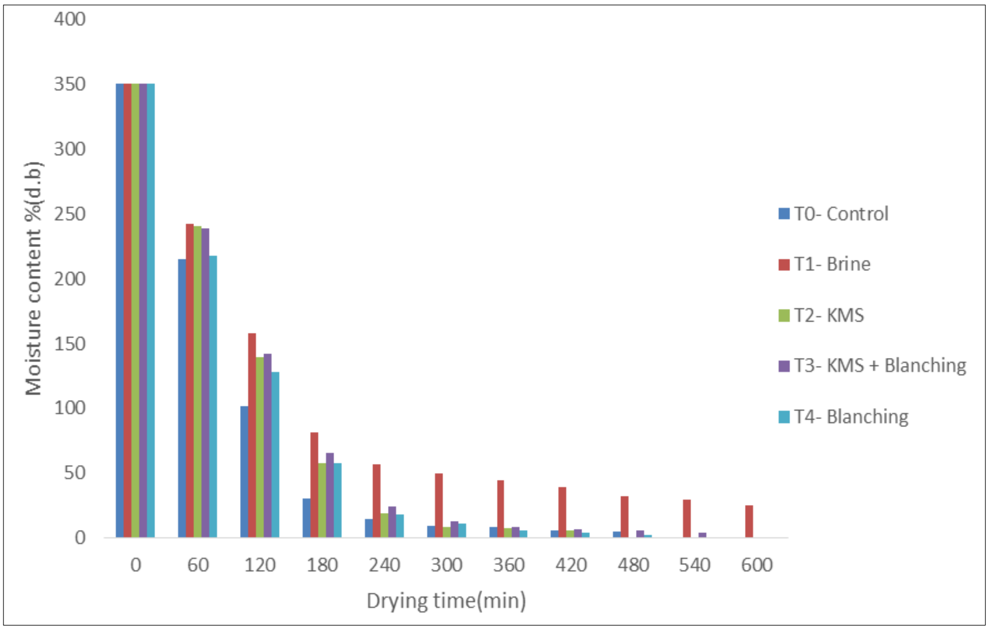

Fig 1: Drying characteristics of pre-treated potato slices (Kufri Chipsona-1) dried at 60^0 C in tray drier

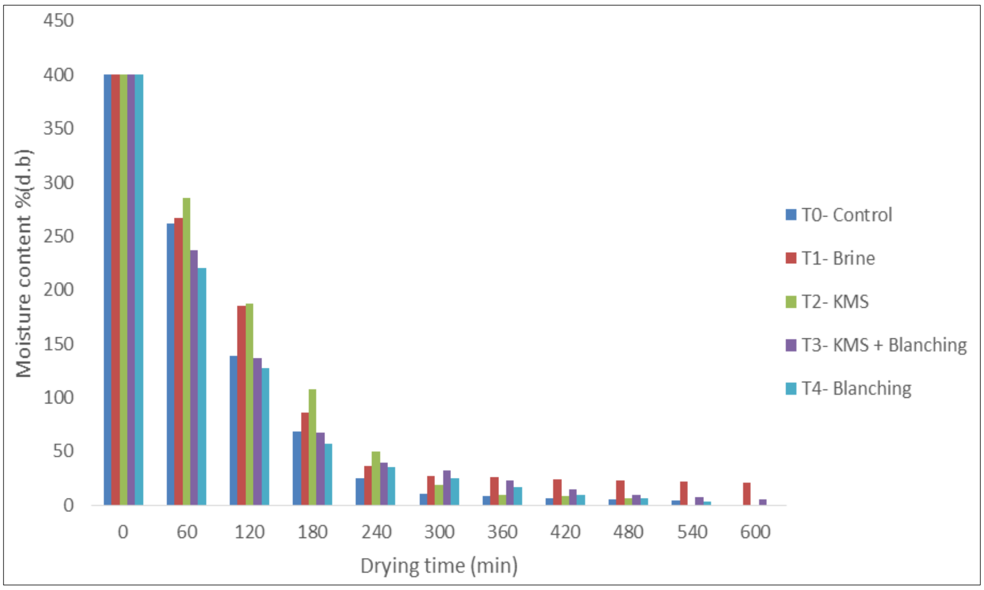

Fig 2: Drying characteristics of pre-treated potato slices (Kufri Jyoti) dried at 60^0 C in tray drier

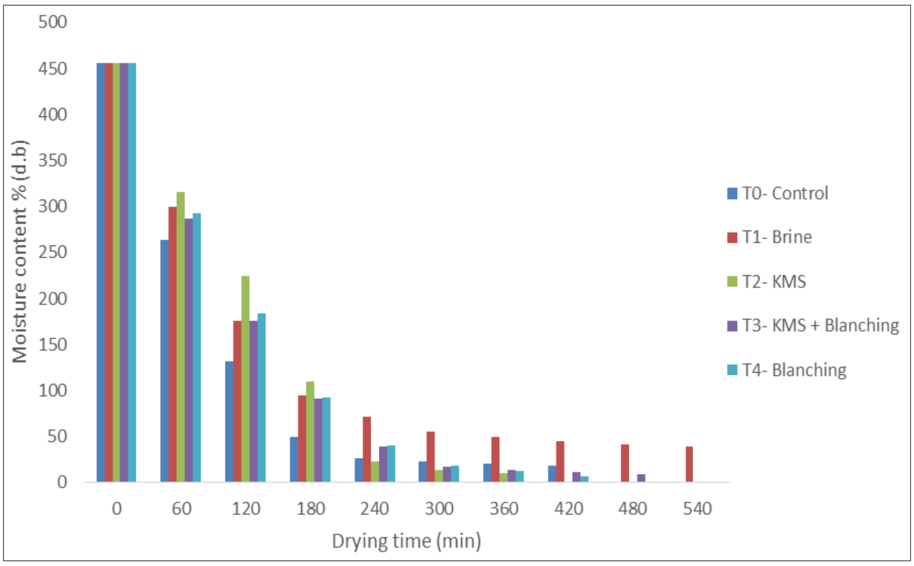

Fig 3: Drying characteristics of pre-treated potato slices (Kufri Bahar) dried at 60^0 C in tray drier

Drying rate

Drying rate was calculated as quantity of moisture removed per unit drying time per unit dry solid. The variations of drying rate with time under different pre-treatment are shown from Fig. 4 to 6. From the Fig. 4 to 6 it was observed that drying rate decreased with increase in drying time and potato slices did not have any constant rate period and the entire drying took place in falling rate period. This shows that diffusion is dominant physical mechanism governing moisture movement in the samples. It was observed that drying rate was higher in the initial period of drying and subsequently reduced with decrease in moisture content. The higher drying rate at the start of drying is due to high surface moisture availability, which evaporates rapidly. Further decreased in drying rate was owned to decreased in available moisture due to low driving force and low moisture diffusion from centre to surface of the dried product. Similar results were found by Rocha *et al.*, 1992 [11]. The highest drying rate of Kufri Chipsona-1 slices was observed in T_2 (KMS treated) followed by T_4 (Blanched treated), T_0 (Control), T_3 (KMS treated) and lowest observed in T_1 (Brine treated). The highest drying rate of Kufri Jyoti slices was observed in T_2 followed by T_4, T_0, T_3 and lowest observed in T_1. The highest drying rate of Kufri Bahar slices was observed in T_2 followed by T_4, T_0, T_3 and lowest observed in T_1.

It could be seen from Fig. 4 to 6 that the drying rates of pretreated potato slice were higher than those of un-pretreated potato slice. This is probably due to softer and looser structure of the pretreated samples, which could facilitate the removal of moisture during drying. The fastest drying rate occurred in the KMS treated samples. The drying rate of potato slices dipped in brine solution was slower than blanched samples due to the presence of salt in solution which inhibits the rate of water transfer from potato slices (Ali *et al.*, 2010) [1]. It is evident from the data that the pretreatments affected the drying rates of potato slices.

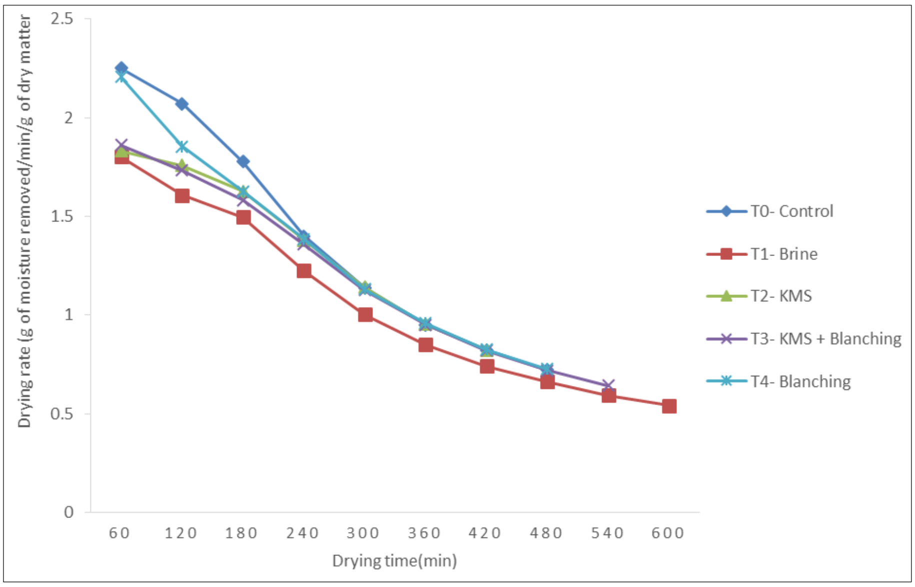

Fig 4: Effect of pre-treatments on drying rate of potato slices (Kufri Chipsona-1)

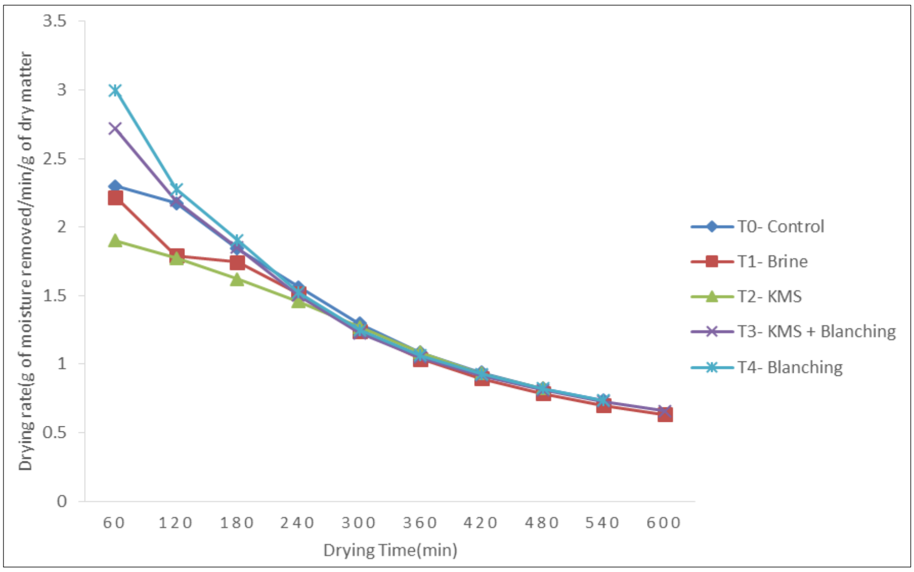

Fig 5: Effect of pre-treatments on drying rate of potato slices (Kufri Jyoti)

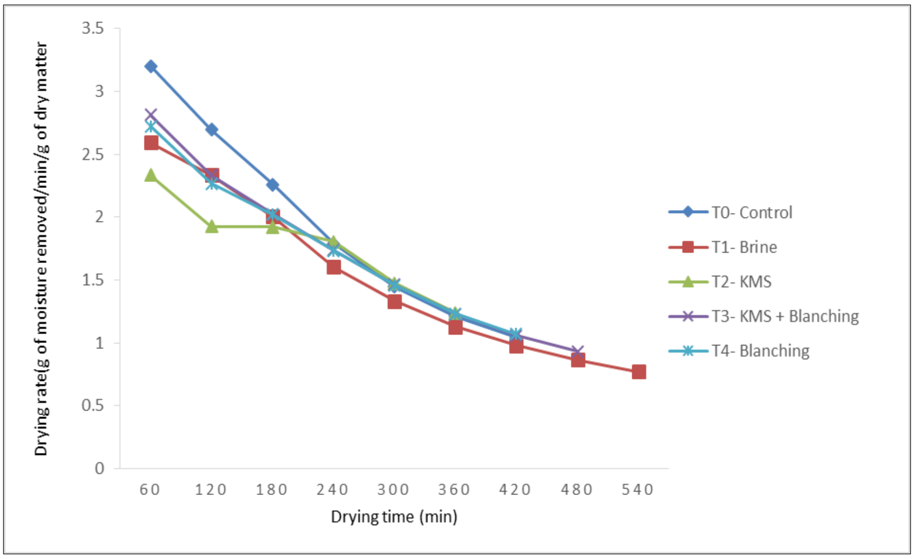

Fig 6: Effect of pre-treatments on drying rate of potato slices (Kufri Bahar)

Conclusion

Potato slices were pretreated with brine solution, KMS solution, KMS plus blanching, blanching and control. It was observed that sample pretreated with brine solution took higher drying time to achieve the final moisture content as compared to other pretreated samples. The KMS treated slices were achieved higher value of drying rate and brine treated slices were achieved lowest drying rate. It was observed that potato slices did not have any constant rate period and the entire drying took place in falling rate period. This shows that diffusion is dominant physical mechanism governing moisture movement in the samples. It was also observed that drying rate was higher in the initial period of drying and subsequently reduced with decrease in moisture content. The drying rate of potato slices dipped in brine solution was slower than blanched samples due to the presence of salt in solution which inhibits the rate of water transfer from potato slices.

References

1. Ali H, Moharram HK, Ramadan MT, Ragab GH. Osmotic dehydration of banana rings and tomato halves. J of American Sciences. 2010; 6(9):383-390.
2. Chantaro P, Devahastin S, Chiewchan N. Production of antioxidant high dietary fiber powder from carrot peels. LWT - Food Sci. Technol. 2008; 41(10):1987-1994.
3. CPRI. Annual report of Central Potato Research Institute of Shimla, 2019.
4. Doymaz I. Drying of potato slices: effect of pretreatments and mathematical modeling. Journal of Food Processing and Preservation, 2011, 1-10.
5. FAO. Trade and Markets Devision. International year of the potato: Economic International Year of the Potato: FAO Factsheets, 2008.
6. FAOSTAT. Food and Agricultural Oranization of the United Nations. International year of the potatoes: FAO factsheets, 2018.
7. Marwaha RS. Evaluation of some potato cultivars for processing on the basis of their chemical composition. J Indian Potato Assoc. 1987; 14:9-16.
8. National Horticultural Reserach and Development Fundation. National seminar on Strategic management of production and post harves technology of onion, garlic and potato from uplifting the livelihhod of farmers, 2019, 26-27.
9. Nilnakara S, Chiewchan N, Devahastin S. Production of

antioxidant dietary fiber powder from cabbage outer leaves. Food Bioprod. Process. 2009; 87(4):301-307.
10. Ranganna S. Handbook of analysis and quality control for fruits and vegetable products. Tata McGraw Hill Publishing Company Limited, New Delhi, India, 2001.
11. Rocha T, Lebert A, Marty-Audoin C. Effect of drying condition on color of mint and basil. In A.S. Muyumber (ED.), 1992, 1360-66.
12. Singh S, Riar CS, Saxena DC. Effect of incorporating sweetpotato flour to wheat flour on the quality characteristics of cookies. African J of Food Sci. 2008; 2:65-72.
13. USDA. Economic Research Service. USDA Economic Research Service - Potatoes. Available from:http://www.ers.usda.gov/topics/crops/vegetables/pulses/potatoes.aspx. Accessed, 2014 Nov 6.
14. Zaheer K, Akhtar MH. Recent advances in potato production, usage, nutrition-a Review. Crit. Rev. Food Sci. Nutr. 2014; 56(6):1-48.