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Some Studies on Drying Characteristics of Potato Slices

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ABSTRACT

The drying characteristic of potato slices were studied by using sun drying, solar drying, tray drying and microwave oven drying. Dried potato powder characteristics were studied.Drying is widely used in a variety of thermal energy applications. Generally, the term drying refers to the removal of a relatively small amount of moisture from solid or nearly solid material by evaporation. In order to improve the quality, the traditional sun drying technique should be replaced with industrial drying method such as hot air and solar drying. The moisture content of potato slices decreased from 87.81% (w.b). The time taken for drying the potato slices was 55 min in microwave oven drying, 4h in tray drying, 8h in solar drying and 14h in open sun drying. The microwave drying took very short period of time (55min) for complete drying of potato slices compared to the all other three methods. The potato slices dried in microwave oven have better colour followed by open sun drying, solar cabinet drying and tray drying. Comparing different driers, the solar dryer produced better quality having more quantity of total soluble solids; total carbohydrates,vitamin- C and reducing sugars.

Key words: *Microwave oven drying, Potato slices, Solar cabinet dryer, Sun drying, Tray drying.*

Potato (*Solanumtuberosum*) is an important vegetable crop. Potato is one of the major tuber crops of the world and most important commercial vegetable grown in India. Potato ranks as 4th major food crop of the world. India occupies the 3rd place in production and 4tharea in the world. InIndia it is grown over an area of 1.41 million ha with an average annual production of 26.28million tones.Potato chips are a food item which is very popular for picnics and may be served at any time as a snack food. At present, many countries are giving emphasis for the preparation of different processed products like potato chips, French fries flakes, flour, starch and conned potato. Among the processed products, chipsare the most popular. Blanching is one of the important unit operations for fruit and vegetable processing. It has been common practice for a long time. During blanching vegetable tissue loses its turgor pressure and rigidity. It becomes more flexible and mechanical handling is easier, blanching also prevents off flavors. By choosing the right temperature time combinations the quality of the end products can be controlled and optimized. Other quality aspects that are affected by the blanching process are texture, colour and nutritional value. Drying is widely used in a variety of thermal energy applications generally the term "drying" refers to the removal of a relatively small amount of moisture from a solid or nearly solid material by evaporation. The main advantages of sun drying are low capital and operating cost. In order to improve the quality, the traditional sun drying technique should be replaced with industrial drying methods such as hot air solar drying. Hence there is need for alternative efficient drying method for food industry to process and preserve food products of high quality. Thermal processing resulted in the increased interest in the use of microwave for food drying.

Waghmare*et al. (*1999) reported for pretreatment the optimum level of NaCl for slice thicknesses of 1 and 1.5 mm was 5%, while for slice thickness of 2 mm, 7.5% NaCl was found optimum. Potassium metabisulphite (KMS) at a concentration of 50 ppm was found optimum for slice thickness of 1 mm, while 100 ppm was found optimum for slice thicknesses of 1.5 and 2 mm. The blanching time of 1 min, however, was found optimum for all the three slice thicknesses. Calcium chloride at 0.25% was found optimum for 1 mm slice thickness, while 0.5% $CaCl_2$ was found optimum for 1.5 and 2 mm slices.

SivajiraoPokkhakar and DilipMahale (2001) Effects of frying time, temperature and thickness of potato slices on oil absorption, moisture content and colour of fresh fried chips have been studied. The loss of reducing sugars was found to have an average diffusivity of 5.01 x $10^{-8}m^2/s$ in case of blanching of 1.5 and 2.0 mm thick slices in boiling water.

Sandhu and Parhawk (2002) reported that desirable characteristics for preparation of dried cubes. The blanching of 1 cm^3 size in boiling 2.0% brine solution for 3 min followed by dipping in 0.2% solution of potassium metabisulphite for 10 min was the best pre-treatment. Among the four drying methods i.e. cabinet drying, sun-drying, combined microwave and cabinet drying and combined microwave and sun drying, the drying of 1 cm^3 size by combined microwave for 17 min followed by cabinet drying at 90±5°C for 2 h produced the best quality dried potato cubes. The composition and quality characteristics of dried cubes were also studied. The sensory quality of curried cubes as vegetable and fried cubes as snack was highly acceptable from the same drying method.

Diamante and Munro (2003) reported that an indirect solar dryer was used to study the drying of sweet potato slices. The solar drying rates of sweet potato slices were affected by the fluctuating chamber temperature over the drying period. Solar drying rate curves exhibited a constant rate period and one linear falling rate period. A mathematical model for solar drying of sweet potato slices was derived based on the simplified form of the Fick's diffusion equation. The mathematical model could satisfactorily describe the solar drying of sweet potato slices to moisture content below 20% dry basis. The mean effective drying chamber temperature and sample thickness were the main factors that affected the solar drying process for sweet potato slices.

Puname*t al*. (2006) In India there is vast scope of dehydration of potato slices through solar drying. In the present study effort have been made to assess the quality of potato chip using different drying methods and pretreatments. The quality of the chips prepared through the different pretreatments and from drying methods were evaluated using standard test methods. It was found that chips prepared with potassium metabisulphite treatment by indirect mode solar dryer have maximum score i.e. 8.0 and the chips prepared with calcium chloride treatment dried in wiremesh sun dryer have minimum score i.e. 5.3.

Agnieszkakita and Adam (2006) the aim of the investigation conducted was determination of the effect of different drying methods (in hot air flow, vacuum and vacuum-microwave dryers) on fat content, texture, colour and sensory properties of potato chips. The material for our investigation were potato chips fried in palm oil at the temperature of 175°C to range 20%, 15% and 5% of moisture and then postdried using different methods to moisture level below 2%. Control sample were potato chips fried to less than 2% moisture. The following parameters were the subject of determination: moisture, fat content, texture – using Instron 5544 device, colour – by Minolta CR-200 colorimeter and sensory properties (like colour, flavour, taste and texture – according to 1-5point scale). Investigations proved that shortening frying time and then post-drying decreases fat content in chips product and increases chips hardness, as well as results in chips lighter colour. It was suggested that post-drying applied at lowered pressure requires assorting appropriate parameters of the process.

Bondaruk *et al*. (2007) The influence of drying conditions on the color, starch content, sugar content, mechanical properties and microstructure of dried potatoes was studied. Statistically significant differences between the color of raw and dried materials were observed for every drying method. It was observed that the vacuum-microwave drying technique prevents color damage during drying. Potato cubes dried in a vacuum-microwave oven had lower starch and total sugar losses than those dried under forced convection conditions. The maximum force values obtained from compression tests indicated statistical differences between samples dried in a microwave-vacuum drier and convection drier. The averaged force and energy required to cause 3 and 5.5 mm deformation were the highest for blanched and hot-air dried (70 °C) potato cubes, and the lowest for vacuum-microwave dried material (24 kPa). The application of microwave energy led to different physical changes in product microstructure, compared to those observed during hot-air drying. The extent of changes was depended on the method

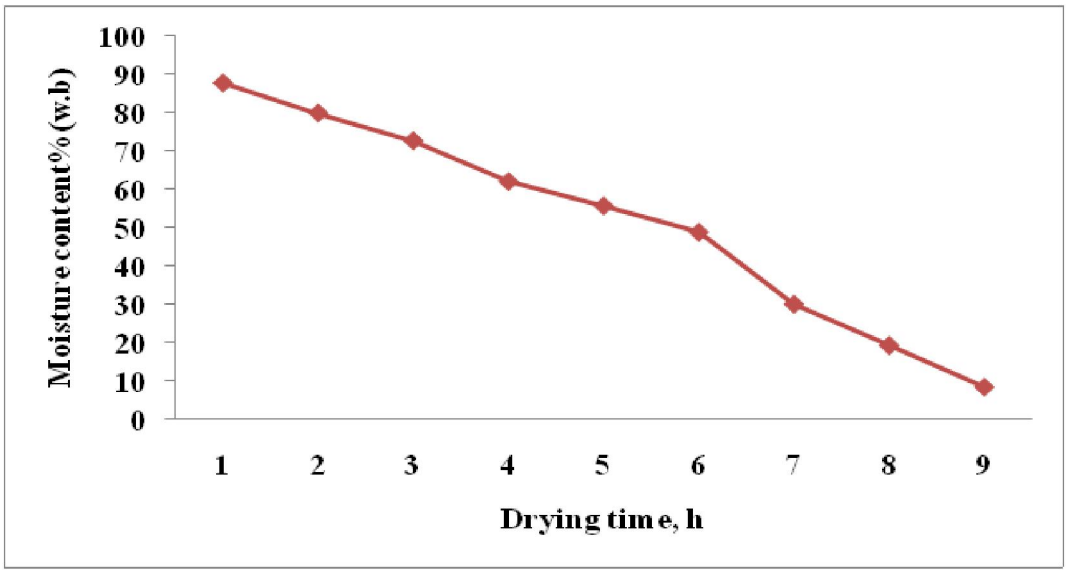

Fig.1. Variation of moisture content with drying time.

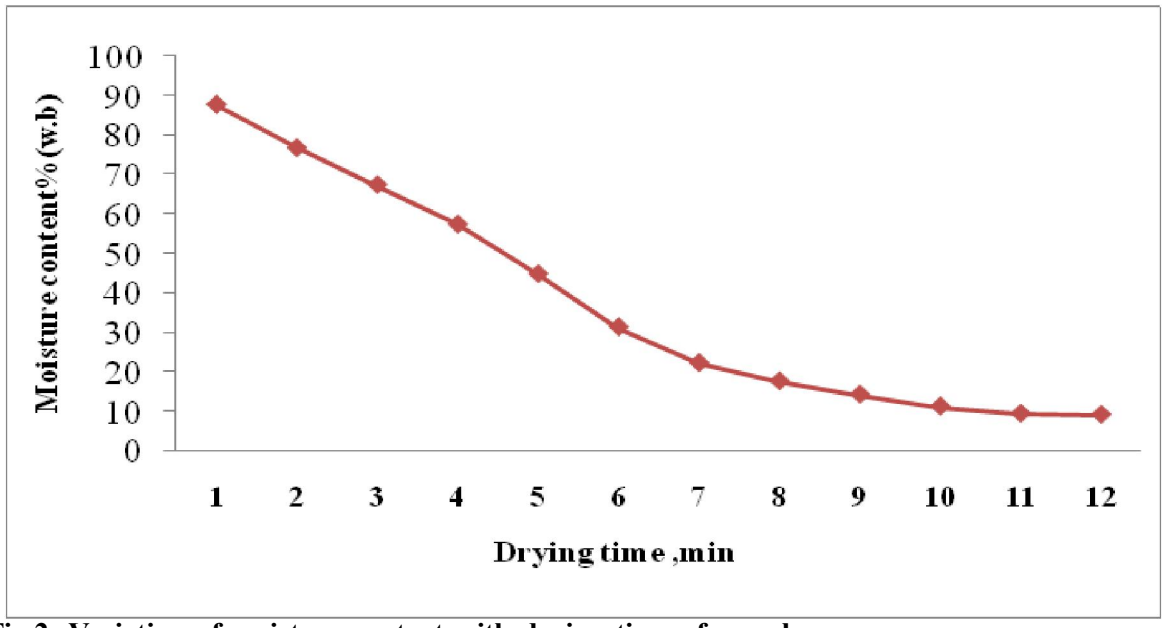

Fig.2. Variation of moisture content with drying time of sample.

and parameters of drying. In both cases the drying process caused deformation and disintegration of cell walls and starch granules. Experiments show that in the case of hot-air drying the intensity of structural changes depends on drying temperature. A higher temperature causes greater damage to the microstructure of potato cubes.

Song *et al.* (2009) Vacuum microwave dehydration characteristics and drying kinetics of potato slices were evaluated using a laboratory-scale dryer. The test materials were placed on a rotating tray to allow uniform exposure to the microwave field. The effect of drying conditions on the drying characteristics was investigated. As expected, higher drying rates were obtained with higher microwave power and lower vacuum levels. The effect of vacuum pressure on drying rate was not as significant as that of microwave power. The Henderson & Pubis model provided better simulation of the drying curves for potato slices. Empirical models are presented for the drying rate constant as a function of the microwave power and vacuum pressure for potato slices under the range of operating conditions tested.

MATERIAL AND METHODS

Potatoes of locally available were procured and the potatoes were washed

thoroughlyto remove the dust. Potatoes were wrapped with tissue paperand peeled and cut into slices of 2mm thick. The open sun drying, solar drier, tray drier and microwave oven were used for drying the potato slices. Hot air oven was used to determine the moisture content of potato slices.

Pretreatment to Sample

It is well known fact that pretreatment is necessary before drying of horticulture produce to reduce the effects of enzymes. Hot water is the usual treatment for inactivation of enzymes in the horticultural produce. Therefore, blanching treatment was given by dipping the potato slices in 0.5% $CaCl_2$solution at 90^0Cfor 3 min(Waghmare*et al.*1999).

Drying of potato slices

Pretreated potato slices were dried under sun, solar, microwave oven, and tray drying till the constant moisture content wasrecorded. The physical and chemical characteristic of dried sample were studied.

Drying Characteristics of Potato Slices

Solar drying:

The Potato slices of 1kgwere taken into a stainlesssteel wire mesh tray of size 100mmx100mm.The trays containing potato slices were placed in the solar drier and drier was exposed to the sun from 8.00 am to 5.00 pm.During the experiment, the air temperature and relative humidity inside and outside the drier were recorded with glass bulb thermometer and hygrometer. During drying, slices were turned upside down frequently. Reductions in weight due to moisture losses were recorded continuously at every one-hour interval. Drying was continued until obtained constant weights. Immediately after drying process, the slices were taken for grinding. The sample was ground in the grinding mill and potato powder was made. Then the ground sample was stored in air tight total carbohydrates,vitamin- C, total soluble solids. The experiment was replicated thrice.

Microwave oven drying:

'Samsung' make micro oven operated at 230V-50Hz AC supply with grill capacity of 250w and operating frequency 245 MHz the outside and inside dimensions of microwave oven are 517X485X310 mm and 350x345x235 mm respectively. The sample size of 1kg of blanched potato slices were placed into the curst plate of oven. The crust plate is placed on the rack stand. Microwave oven was operated in grill mode which is used for drying purpose. Then the drying time was set by choosing and pressing the 10min/loption buttons. The maximum heating time in grill mode was set to 5min. the operating was started by pressing the start button. The oven light comes on and the turntable starts rotating. Drying starts and when the set time of drying is finished, the oven beep sound. The experiment was continued till the samples were completely dried. After drying, the dried samples were taken out. During drying, the slices were stirred frequently. Reduction of losses isrecorded continuously at every 5 min interval.

Tray drying:

The tray dryer, essentially having a cabinet into which the material to be dried is placed on trays. It mainly consists of a thermostat, fan and temperature controller. The tray dryer having12 no. of trays placed one above another. The air velocity in the tray dryer varies from 03.m/s to 2.3m/s. The potato slices kept in clean aluminum trays. Those trays were kept in tray dryer for drying potato slices were dried were dried at 65^oc and constantduring air was circulated at105m/s was maintained during drying. The drying time was noted every 1hr interval until the samples was dried to moisture content of approximately below 10 %(w.b).The dried sample are takenout from the tray and cooled to room temperature. The dried potato slices were made in powder by 'Willey' makemill.

Open sun drying:

About 1kg of pre treated potato slices were taken into a rectangular thermo-coal plate and slices are spread uniformly. Then the plate is placed in open sun for drying. During drying, the slices were frequently stirred manually. Reduction in weight due to moisture loss was recorded continuously at every one hour interval. Drying was continued until there was no variation in the moisture loss immediately after drying process. The slices were taken into grinding mill and sample is made into potato powderusing fine mesh. Later the powder was

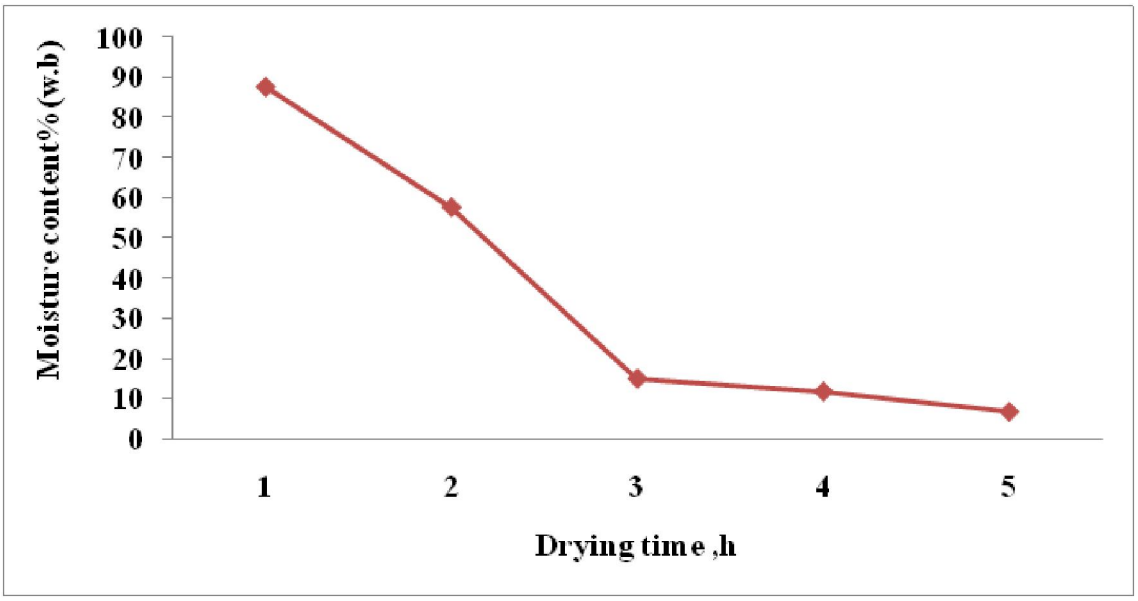

Fig. 3. Variation of moisture content with respect to drying time.

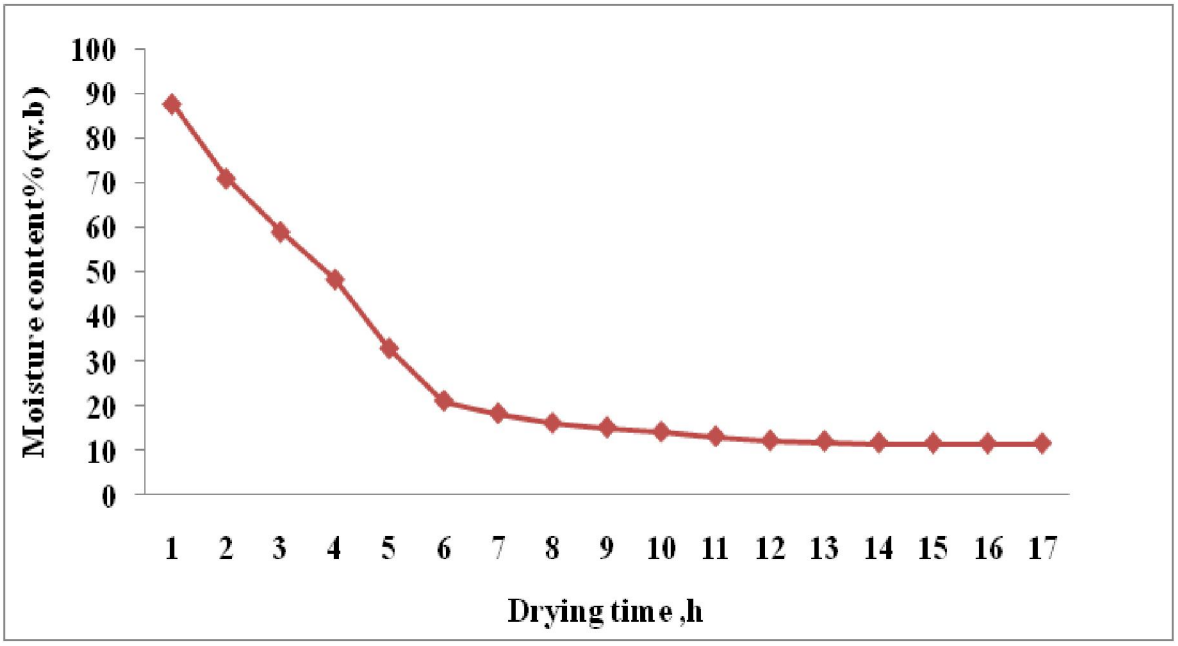

Fig.4. Variation of moisture content with drying time in open sun drying.

analyzed for reducing sugars, total carbohydrates,vitamin- C and soluble solids. The experiments were replicated thrice.

Willey Mill:

'Willey' makemill was used for grinding the dried potato slices. The dried slices were fed manually to Willey mill, for making powder. The powder obtained was stored in airtight plastic containers. Later the powder was used for analyzingSolanumtuberosumcontent, Reducing sugars, Ascorbic acid, Total Soluble solids, pH and Total carbohydrates.

RESULTS AND DISCUSSION

Solar drying

The sample size of 1000 g of blanched potato slice with moisture contact 87.81% (w.b) was taken into 100 mmx100 mm mesh trays and placed inside the solar cabinet drier. The slices were exposed to sun on the bright sunny day from 8.00 a.m. to 5.00 p.m. During the drying process, at

every one-hour time interval, the moisture contents of potato slice were determined. The moisture content of samples decreased from 87.81 to 8.69 %(w.b.) in a total drying period of 16 hours. From Fig.1, it is clear that the moisture content of slices decreased with elapsed time. Through the difference in moisture content at 7 hours (19.51%w.b.) and 8 hours (8.69%w.b.) is very small and the drying is further continued until the dried slices could be easily breakable.

Microwave oven drying

The 1000g sample of potato slices dried in microwave oven for 55min. The sample was kept inside the metallic tray stands of the microwave oven and the oven was set to gill mode (heating mode) and pre set time of 55min, the oven was put on. The moisture content of sample is decreased from 87.62 %(w.b) to9.10%(w.b)in a drying period of 55min. From Fig.2, itcan observed that the rate of decreasein moisture content was higher in microwave oven drying and the drying was completed in a very short period of time i.e.within 55 min.

Tray drying

The 1000g of pretreated potato slices at 87. 81%(w.b) moisture content was taken into 100mmx100mm mesh tray and placed inside the tray drier from 8.00am to5.00pm.During drying process, at every one-hour interval, the moisture content of potato slices was determined. The moisture content was decreased with time. Initially higher moisture loss was observed due to release of free moisture as compared to the later part of drying. The potato slices dried at the temperature of 65°Cshowed better quality.

Open Sun drying

The sample was kept in open sun dryingat 8.00am on clear sunny day and continuedtill 5.00pm. The partly dried sample was wrapped in a polythene cover. On the next day partly dried sample was again exposed to open sun and it was dried to a final moisture content of 11.42 %(w. b).During drying process, at every one-hourinterval the moisture content of sample was determined.Fig.4 shows the variation of moisture content with respect to drying. The moisture content of samples decreased from 87.76% to 11.42% in a total drying period of 16h. It is clear that the decrease in moisture content is at faster rate up to first 6h of drying period and later it was found slower upto10h of dryingtime, the moisture content was decreased from 13.01% to11.42 %.

Proximate Analysis

The solar dried sample contained 13.37g/ 100g, 10g/100g, 63.5 g/100g and 56.2g/100g of vitamin- C. Reducing sugar, total carbohydrates and TSSrespectively. The microwave oven dried sample contained 9.30g/100g,10.1/100g,60g/100g and 53.2g/100g of vitamin- C reducing sugar, carbohydrates and TSSrespectively. The tray dried

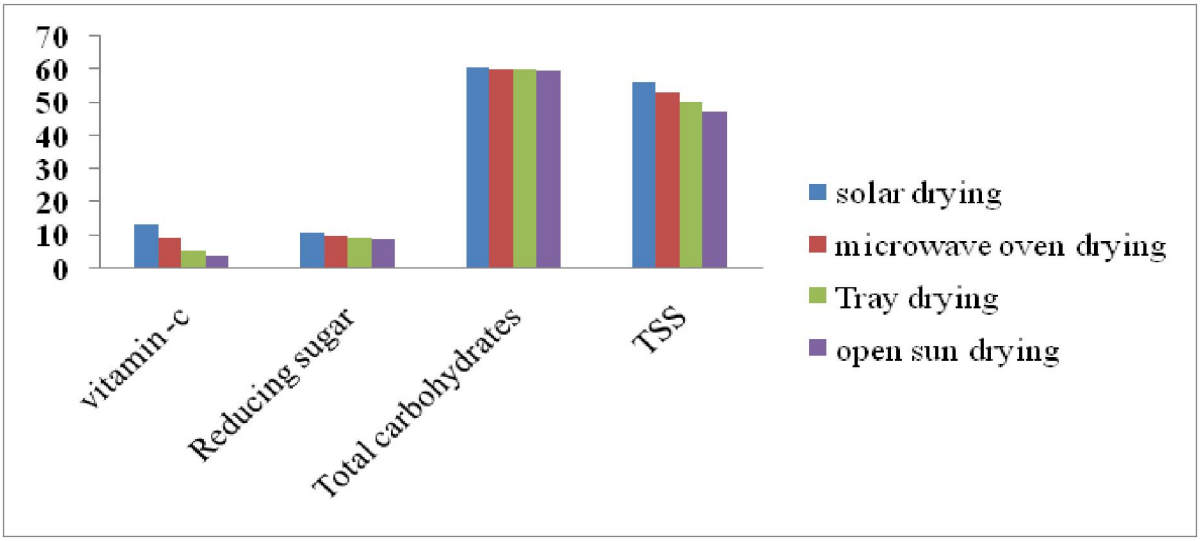

Fig.5. Proximate analysis of potato powder against different drying methods.

sample contained 5.20g/100g9.6g/100g,60.2g/100g,and 50.2g/100g of vitamin- C reducing sugar, total carbohydrates and TSS respectively. Fig.5shows the variation of vitamin –c reducing sugar, total carbohydrates and TSS of samples dried in four different methods. The solar dried samples contain high amount of vitamin- C reducing sugar, total carbohydrates and TSS as compared to three methods.i.e tray drying, microwave oven and solar drying methods. The solar dried sample contained higher amount of vitamin- C, reducing sugar, total carbohydrates and TSSrespectively. From the result of drying experiments, proximate analysis tests, the potato powder produced in solar drier may be considered as better quality product compared to the other three drying methods. If drying time is only considered as parameter, potato powder produced in microwave oven drying may be chosen.

Conclusion

The moisture content of potato slices decreased from 87. 81%(w.b) to final moisture content of 8 to 10% (w.b).The time taken to drying the potato slices was 55 min in microwave oven drying.4h in tray drying.8h in solar drying and 14 h in open sun drying. The microwave drying taken very short period of time (55 min) for complete drying of potato slices compared to the all other three methods.The potato slices dried in microwave oven has better colour and followed by open sun drying, solar cabinet drying and tray drying.Comparing different drier, the solar dryer produced better quality having more content of TSS, total carbohydrates,Vitamin-C and reducing sugars.Solar dried sample contained Vitamin-C (13.37mg/100g),reducing sugar(10.6 mg/100g), total carbonates (60.5mg/100g) and total soluble solids (56.2mg/100g) respectively.The microwave oven dried sample contained 9.30mg/100g,10.1mg/100g,60mg/100g and 53.2mg/100g of Vitamin-C reducing sugars, total carbohydrates and TSS respectively.The tray dried sample contained 5.20 mg/100g,9.6 mg/100g,60.2mg/100g,60mg/100g and 50.2mg/100g of Vitamin-C reducing sugars, total carbohydrates and TSS respectively.The amount of reducing sugar is more in Potato powder dried in solar drier compare to tray and microwave oven.

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