RESEARCH PAPER | International Journal of Agricultural Engineering | Volume 12 | Issue 2 | October, 2019 | 243-250
ISSN–0974–2662 ■ Visit us : *www.researchjournal.co.in* ■ **DOI: 10.15740/HAS/IJAE/12.2/243-250**

Evaluation of physico-chemical characteristics of cauliflower slices at different pre-treatment and drying condition

■ **Vipin Kumar Verma and Devendra Kumar**

Received : 03.07.2019; **Revised :** 27.08.2019; **Accepted :** 14.09.2019

See end of the Paper for authors' affiliation

Correspondence to :

Vipin Kumar Verma
Baba Saheb Dr. Bhim Rao Ambedkar College of Agricultural Engineering and Technology, **Etawah (U.P.) India**
Email:vipincaet79@gmail.com

■ **ABSTRACT :** Experimental study was conducted to evaluate cauliflower slices using tray drying and microwave drying techniques. Pretreatment of cauliflower slices as unblanched, blanched and blanched with KMS and dried in tray dryer at different temperature (45, 55 and 65°C) and in microwave at different power level (20W, 40W and 60W). The physico-chemical qualities (moisture content, drying rate, rehydration ratio and retention of vitamin C) were evaluated just offer preparation of cauliflower slices. The moisture content decreased continuously with drying time and increasing the drying temperature. Moisture loss increased from cauliflower with increased in power of microwave and time of drying. The drying rate of cauliflower slices under tray drying decreased as the drying time progressed and finally attained zero drying rate. The pretreated samples were taken shorter drying time. Statistical analysis indicated that drying time was dependent on initial size of cauliflower, drying air temperature and velocity, but rehydration ratio was significantly affected by the combined effect of temperature and airflow velocity. Vitamin C content of the dried cauliflower samples browning was function of temperature, airflow velocity and combined effect of temperature and airflow velocity. The ascorbic acid retention of microwave and tray dried samples had the highest ascorbic acid retention for KMS blanched samples. KMS blanched samples had highest rehydration ratio in tray dryer while as rehydration ratio of KMS blanched cauliflower was highest at every power level of microwave dryer. The rehydration ratio was acceptable 40W power level. Microwave power drying was found most suitable for KMS blanched cauliflower slices at low power level.

■ **KEY WORDS :** Cauliflower slices, Tray dryer, Microwave, Moisture content, Drying rate, Vitamin C, Rehydration ratio

■ **HOW TO CITE THIS PAPER :** Verma, Vipin Kumar and Kumar, Devendra (2019). Evaluation of physico-chemical characteristics of cauliflower slices at different pre-treatment and drying condition. *Internat. J. Agric. Engg.*, **12**(2) : 243-250, **DOI: 10.15740/HAS/IJAE/12.2/243-250.**

Cauliflower is a cole crop belonging to family Cruciferae and botanical name is *Brassica olaracea* var. botrytis. Cauliflower was introduced in India in 1822 (Lund *et al.*, 1972). World production of cauliflower is 13.5 million tonnes. Although India is the highest producer of cauliflower, its productivity is lower than average (Mudgal and Pandey, 2008). Major states producing cauliflower are Bihar, Uttar Pradesh, Orissa, West Bengal, Assam, Haryana and Maharashtra. Cauliflower is a rich source of vitamin B. Cauliflower is one of the most important winter vegetable of India. India produces 8090000 MT of cauliflower with area 426000 ha NHB(2015-16). The edible portion of cauliflower is 45 per cent. Cauliflower is a popular and highly priced winter vegetable, perishable in fresh condition. The estimated post harvest loss per hectare in India is about 49 per cent (Sehgal,1999), vegetables in general beneficial for human and saved against lung disease, gastrointestinal tract, prostrate cancer and glucosinolates. Indole-3-carbinol, a chemical that enhances DNA repair and acts as an estrogen antagonist slowing the growth of cancer cells. A high intake of cruciferous vegetables has been associated with reduced risk of aggressive prostate cancer, therefore, a growing and urgent need for simple, inexpensive processes that would offer away to save these highly perishable commodities from spoilage conventional dehydration and canning processes which have many drawbacks with rigid structures with need rehydration for prolonged periods and generally have texture and flavour inferior to the fresh materials, it is unsuitable due to shrinkage to toughness caused by slow prolonged drying (Jayarman,1998). One of the alternatives to dried vegetable is the intermediate moisture (IM) foods. IM foods are easy to prepare and store without refrigeration. They are not readily subject to spoilage, even if packages have been damaged prior to opening as with thermo stabilized foods, because of low aw, this is a plus for many developing countries, especially those in tropical climates with inculcate infrastructure for processing and storage, offers marketing packages for consumers all over the world (Gustavo *et al.,* 2003). Development of intermediate moisture foods is based on an increased scientific understanding of the chemical reaction involved in traditional food preservation methods (Vora *et al.*, 2003). Gamma irradiation has long been employed for decontamination and or sterilization of dehydrated vegetables. However, use of radiation technology to minimize or avoid the use of other hurdles has been very limited. Many molecules (such as water) are electric dipoles, meaning that they have a positive charge at one end and a negative charge at other and, therefore, rotate as the rotating molecules hit other molecules and put them into motion (Sutar and Prasad, 2008).

Lewicki (1998) investigated the effect of orgnoleptic properties upon rehydration. Five gram of dehydrated sample was put into a small container and 55 ml of water was added. Container was covered with glass and the water was boiling gently for 20 min. After boiling the excess water was removed using filter paper then the weight of sample was recorded. Mudgal and Pandey (2007) reported that processing can be alternate for extending the shelf-life. Dehydrated cauliflower can be used to enhance the taste and nutritional value of various product such as vegetable soup canned product extruded product etc. Radhakrishnan (1999) reported the level of fruits and vegetable processing in India is hardly 2 per cent of the total production whereas countries such as Thailand, Brazil, Philippines and Malaysia process 30 per cent, 70 per cent, 78 per cent and 83 per cent their produce, respectively. Fruits and vegetables are important sources of essential vitamins and minerals for human consumption. Different fruits and vegetable have their own unique mix of demands to preserve fruits and vegetable so that their useful characteristics can be reaped during unavailability. Removal of water from food is the essence to enhance the shelf-life of vegetable and dehydration is one of the techniques widely used to preserve agriculture produce. Dehydration simultaneously combines heat and mass. Neelavathi *et al.* (2013) studied the dehydration process of cauliflower in CVS. Pusa Sharad, Pusa Hybrid-2 and Pusa himjyoti. All the samples were then subjected to boiling in the microwave oven and the electrical conductivity reading were recorded after cooling 25^{o}C. Time of blanching was standardized 4-7 and 5 min, for water steam and microwave blanching. Cauliflower florets were deeped in hot water (90± 5^{o}C) for 4 min. During water blanching, steam blanching, florets taken in wire mesh sieve and placed above a containing boiling water for 7 min. The temperature during blanching was 90±2 ^{o}C. Microwave blanching was done using domestic microwave steam blanching retained higher level of quality and ascorbic acid followed by microwave. Jayarman (1982) blanched potato, carrot in boiling water of 0.1 per cent potassium meta bisulphate for a period of 5 min and dried to 5 per cent moisture in a conventional dryer with 70^{o}C temperature for hot drier. Mazza (1983) reported that freezing and blanching of carrot slabs increase the drying rate. Nath and Katara (1985) worked on drying of 0.75 and 1.75 cm cubes of three varieties of Kufri Badshah, Kufri Muthu and Kufri Jyoti. Kanwade *et al.* (1995) reported that blanching of fruit and vegetable is principally followed to inactivate the enzymes responsible for enzymatic and oxidative browning. Premi *et al*. (1997) reported that the effect of white specks was less in aonla segments preserved in steeping solution containing 10 per cent salt and 0.04

per cent KMS than in those preserved by dry, salting with 10 per cent salt and 0.02 per cent KMS during one month storage. Krokida and Maroulis (2001) reported that the rehydration characteristics of dried product had influenced by the method of producing sample, constitute preparation of the sample, prior to rehydration and extent of the structural chemical changes include by drying.

Therefore, the study was undertaken to evaluate physico-chemical characteristics of cauliflower slices at different pre-treatment and tray drying temperature and microwave power level.

METHODOLOGY

Good quality fresh cauliflower was purchased from local market and damage and immature pieces of cauliflower were removed manually by visually inspection and experiment was conducted in post harvest technology laboratory. Cauliflower fresh and good pieces were sliced with help of knife. The slices of cauliflower were washed in tap water and the sample was drained to remove the excess water for unbalanced sample. After washing, the sliced cauliflower pieces were blanched by tying them in muslin cloth and dipping the sample in boiling water for 5 minutes. Similarly, sliced cauliflower pieces were blanched with sodium benzoate by tying them in muslin cloth and dipping the sample in boiling water for 5 minutes. The blanched with sodium benzoate sample were cooled immediately by keeping them under flowing water to prevent over cooking of the sample and drained to remove the excess water for blanched (1% sodium benzoate) sample. The dried slices were obtained after tray drying. The experiment for the samples was carried out until constant weight achieved using inlet hot air temperature 45, 55 and 65°C. The pre-treated cauliflower slices were dried in a microwave dryer. Drying was carried out at three different microwave -generation power being 20, 40 and 60 watt and two pre-treatment. The sample of cauliflower slices was dried simultaneously, in order to ensure uniform drying conditions. After the dried cauliflower slices were analyzed for different physio-chemical analysis. Moisture content, drying rate, vitamin C and rehydration ratio were analyzed as:

Moisture content:

A standardization procedure of AOAC was followed to estimate the moisture content of samples.

$$\text{Moisture content (\%)} = \frac{m_1 - m_2}{m_1 - m_d} \times 100 \qquad ....(1)$$

where,

m_1 = Weight of sample before over drying + weight of dish with cover, g.

m_2 = Weight of dish containing drying and dessicating sample + weight of dish with cover, g.

m_d = Weight of bone dry material, g.

Drying rate:

$$\text{Drying rate} = \frac{\text{Amount of moiture removed (g)}}{\text{Time taken (min) x Total bone dried weight of sample (g)}} \qquad ...(2)$$

Similarly, the drying rate was approximately proportional to the difference in moisture content between the product being dried and EMC and the drying air state.

$$DR = \frac{Mt + dt - Mt}{dt} \qquad ...(3)$$

where,

Mt = Moisture content at time t (% db)

Mt+dt= Moisture content at time t+dt (%db)

dt= Time of successive measurement.

Vitamin C:

Vitamin C of dried cauliflower (*Brassica olerace*. Bortrytis) samples was determined by 2,6-Dichlorophenol Indophenols dye titrimetrically as per the modified procedure of AOAC.

$$\text{Ascorbic acid (mg/100g)} = \frac{0.5 \times V_2 \times 100}{V_1 \times 5 \times \text{wt. of sampes}} \times 100 \qquad ....(4)$$

where,

V_1 = Amount of dye consumed by ascorbic acid present in the working standard solution

V_2 = Amount of dye consumed by sample.

Rehydration ratio:

The process of restoring lost water (dehydration) to the body tissues and fluids. Prompt rehydration is imperative whenever dehydration occurs, from diarrhea, exposure, lack of drinking water, or medication use. Rehydration can be by the oral route or by the intravenous administration of fluids.

$$\text{Rehydration ratio} = Wd \times Wr \qquad ....(5)$$

where,

Wd = Weight of the dried samples, g
Wr = Weight of the after rehydration, g.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Tray drying characteristics:

Experiments were conducted to study the tray drying and microwave drying characteristics of cauliflower slices at different temperature and power levels. Cauliflower samples were packed in HDPE bags and stored at room temperature. Studies on quality were based on physico-chemical characteristics (moisture content, drying rate, rehydration ratio and ascorbic acid content) which were determined for fresh samples.

Effect of pre-treatment and tray dryer on moisture content of cauliflower during drying process:

Cauliflower slices were dehydrated in tray dryer at air temperature 45°C, 55°C and 65°C to final equilibrium moisture content. The initial average moisture content of unblanched, blanched and blanched with KMS cauliflower samples was 1493.76 per cent (db). The moisture content decreased very rapidly during the initial stage of drying, as there was fast removal of moisture from the surface of the product. Decrease in drying rate with respect to time suggests a decreased drying rate with the decrease in moisture content. The moisture content decreased continuously with drying time and increasing the drying temperature. Different results were obtained in which the pre-treatments affect the drying time. The pre-treated samples were found to be have a shorter time as compared to unblanched sample. It is observed that the drying time required for reducing the moisture content of pre-treated samples were taken different drying time. Thereafter, the moisture content of samples was decreased slowly with increase in drying time and attained final equilibrium moisture content. Similar results were also obtained by Mudgal and Pandey (2008). This is due to the partial vapour pressure of moisture present in samples initially being more is compression to that of the external environment (surrounding of the samples). At the initial stage of drying moisture starts migrating rapidly from the samples to the external environment because of higher partial vapour pressure difference between samples and environment. At 45°C air temperature, the initial moisture content of unblanched, blanched and blanched with KMS slices were 1399.25 per cent, 1576.45 and 1548.80 per cent (db), respectively. Cauliflower slices were reduced moisture content to 2.86 per cent, 3.49 per cent and 3.35 per cent (db) at the end of 440, 320 and 400 min drying, respectively. At 55°C drying air temperature, the initial moisture content of the cauliflower unblanched, blanched and blanched with KMS slices were 1538.14 per cent, 1338.85 per cent and 1527.34 per cent (db), respectively. The cauliflower slices were reduced to 5.93 per cent, 7.35 per cent and 4.99 per cent (db) at the end of 280, 240 and 220 minutes, respectively. Moisture content of cauliflower was found to decrease rapidly during the initial 148 min. At 65°C drying air temperature rate, the initial moisture content of the unblanched, blanched and blanched with KMS cauliflower slices were 5.90 per cent, 4.88 per cent and 1.41 per cent at the end of 260, 200 and 180 minute, respectively.

Effect of pre-treatment and tray dryer on drying rate of cauliflower slices:

The drying rate decreased with the increase in drying time and the decreased moisture content. After some period drying rate decreased rapidly with the increase in drying time and the decreased gradually and attained approx zero drying rates. Similar results were also obtained by Wang and Brennan (1995). The moisture content of cauliflower slices was relatively higher during the initial phase of drying resulting in higher absorption of heat and lead to in increased products temperature and higher drying rate to higher moisture diffusion. As the drying of cauliflower slice progressed, the loss of moisture in the product decreased the absorption of heat and resulted in full drying cauliflower slices had highest drying rate. At 45°C air temperature, the drying rate of the unblanched, blanched and KMS blanched cauliflower slices were 0.074, 0.117 and 0.087 g/min/g, of dry matter at the end of first 5 minutes drying, respectively. It decreased gradually and attained near about zero drying rate at end of 480, 360 and 420 minutes drying, respectively. At 55°C air temperature, the draying rate of KMS blanched cauliflower slice had highest drying rate. The drying rate of the unbleached, blanched and KMS blanched cauliflower slices were 0.104, 0.115 and 0.139 g/min/g, of dry matter at the end of first 5 minute drying, respectively. It decreased gradually and attained near about zero drying rate at the end of 320, 280 and 260 minutes drying, respectively. At 65^{o}C air temperature, the drying rate of blanched cauliflower slice had highest drying rate. The drying rate of the unblanched, blanched and KMS blanched cauliflower slices were 0.0976, 0.182 and 0.150 g/min/g. of dry matter at the end of first 5 minute drying, respectively. It decreased gradually and attained near about zero drying rate at the end of 300, 240 and 220 minutes, respectively.

Microwave drying characteristics:

Cauliflower slices were dehydrated in microwave dryer at 20W, 40W and 60 W to final equilibrium moisture content.The initial average moisture content of cauliflower slices was 1389.08 per cent (db). The moisture content decreased very rapidly during the initial stage of drying. With increasing drying power, the amount of moisture removed from cauliflower slices increased and time to achieve final moisture content in finished product was reduced.

Effect of pre-treatment and microwave dryer on moisture content of cauliflower during drying process:

The initial average moisture content of unblanched, blanched and blanched with KMS cauliflower samples was 1389.08 per cent. the moisture content decreased continuously with drying time and increasing the drying power. Different results were obtained in which the pre-treatments affect the drying time. The pre-treated samples were found to be have a shorter time as compared to unblanched sample. It was observed that the drying time required for reducing the moisture content of pretreated sample were taken different drying time. Thereafter, the moisture content of samples decreased slowly with increase in drying time and attained final equilibrium moisture content. With increasing the drying power level the amount of moisture removed from cauliflower increased and time to achieve final moisture content in finished product was reduced. The unblanched samples at 20W, 40W and 60W took shorter time than other. At 20 watt initial level moisture content of unblanched blanched and blanched with KMS samples were observed about 1206.33, 1369.5 and 1438.46 per cent (db), respectively. Cauliflower slices were reduced moisture content to 1.50 per cent, 1.16 per cent and 4.61 per cent (db) at the end of 28, 30 and 29 minutes drying, respectively. At 40 watt initial level moisture content of unblanched, blanched and blanched with KMS samples were observed about 1314.42, 1477.28 and 1471.09 per cent (db), respectively. Cauliflower slices were reduced to 3.04 per cent, 1.156 per cent and 3.87 per cent (db) at the end of 25, 29 and 29 minutes drying, respectively. At 60 watt initial level moisture content of unblanched, blanched and blanched with KMS samples were observed about 1283.12, 1391.42 and 1550.16 per cent (db), respectively. Cauliflower slices reduced moisture content to 2.85 per cent, 1.72 per cent and 7.88 per cent (db) at the end of 25, 32 and 28 minutes drying, respectively.

Effect of pre-treatment and microwave dryer on drying rate of cauliflower:

The effect of drying rates of samples under microwave drying indicating that the drying rate decreased with the increase in drying time and decreased moisture content. After some period, drying rate decreased rapidly with the increase in drying time and then decreased gradually and attain approx zero drying rates. The moisture content of cauliflower slices was relatively higher during the initial phase of drying resulting in higher absorption of heat and lead to in increased product power level and higher drying rate to higher moisture diffusion. As the drying of cauliflower slice progressed, the loss of moisture in the product decreased the absorption of heat and resulted in full drying rate during latter part of the drying. At 20 W and 60W power level, the drying rate of KMS blanched cauliflower slice had highest drying rate. At 40W power level, the drying rate of blanched cauliflower slice had highest drying rate. The pre-treated sample was found to be having a higher drying rate with shorter drying time as compared to unblanched samples. The enhancement in drying rate at high microwave power is due to the fact that higher drying power lead to higher driving forces for heat transfer. Beginning drying rate was less than final drying rate of the samples after starting increased gradually and after some time decreased to approximately zero drying rate.

Effect of temperature on the ascorbic acid:

In most of the cases ascorbic acid decreased with increasing temperature, power and time. Similar results were also obtained by Yadav and Sehgal (1997). The vitamin C content for unblanched, blanched and blanched with KMS samples were found 333.34, 306.67 and 366.67 mg/100g at 45°C temperature where as 316.66, 290.00 and 350.00 mg /100g at 55°C temperature in tray dryer, respectively. The vitamin C content for unblanched, blanched and blanched with KMS samples were obtained 280.00, 250.67 and 300.00 mg/100g at 65°C temperature in tray dryer. The vitamin C content for unblanched, blanched and blanched with KMS samples were found 166.67, 153.33 and 200.00 mg/100g at power 20 watt in microwave power dryer. The vitamin C content for unblanched, blanches and blanched with KMS samples were obtained 133.34, 123.33 and 143.33 mg/100g whereas 96.67, 83.33 and 116.66 mg/100g at power 60 watt in microwave dryer, respectively.

Rehydration ratio:

Rehydration ratio of dried cauliflower slices of unblanched, blanched and blanched with KMS were observed 8.02, 7.92 and 7.29 per cent at 45°C, respectively where as 7.60, 6.21 and 6.08 at 55°C, respectively and rehydration ratio of dried cauliflower slices of unblanched, blanched and blanched with KMS were observed 7.34, 5.68 and 5.61 at 65°C, respectively (Table 1). Rehydration ratio of dried cauliflower slices in microwave dryer were observed 4.74, 4.97 and 5.05 at 20 watt, 6.53, 4.96 and 7.62 at 40 watt and 5.49, 4.94 and 5.56 at 60 watt for unblanched, blanched and KMS blanched slices, respectively (Table 2). The tray dried unblanched sample rehydration ratio ranges greater than pre-treated samples whereas in microwave dried blanched with KMS samples had highest rehydration ratio. In tray dryer, unblanched samples were acceptable at 45°C, 55°C and 65°C which were observed 8.024, 7.602 and 7.344, respectively. In microwave dryer KMS blanched samples were acceptable at 20, 40 and 60 W which were observed 5.056, 7.622 and 5.566, respectively. Rehydration ratio of dried cauliflower slices of unblanched sample had higher rehydration ratio compared to pre-treated sample with increased temperature, power and time in tray drying. Similar

Table 1: Effect of pre-treatment on rehydration ratio of cauliflower samples (unblanched, blanched and blanched with KMS) dried at different temperature in tray dryer

Pre-treatment	Temperature (°C)	Initial weight of sample (g)	Final weight of sample (g)	Rehydration ratio
Unblanched	45	5	40.12	8.024
Blanched	45	5	39.604	7.920
Blanched with KMS	45	5	36.46	7.292
Unblanched	55	5	38.01	7.602
Blanched	55	5	31.06	6.212
Blanched with KMS	55	5	30.42	6.084
Unblanched	65	5	36.72	7.344
Blanched	65	5	28.43	5.686
Blanched with KMS	65	5	28.06	5.612

Table 2: Effect of pre-treatment on rehydration ratio of cauliflower samples (unblancher, blanched and blancher with KMS) dried at different power level in microwave dryer

Pre-treatment	Power in (watt)	Initial weight of sample (g)	Final weight of sample (g)	Rehydration ratio
Unblanched	20	5	23.7	4.74
Blanched	20	5	24.87	4.97
Blanched with KMS	20	5	25.28	5.056
Unblanched	40	5	32.68	6.536
Blanched	40	5	24.8	4.96
Blanched with KMS	40	5	38.11	7.622
Unblanched	60	5	27.45	5.49
Blanched	60	5	24.74	4.94
Blanched with KMS	60	5	27.83	5.566

results were also obtained by Lewicki (1998). Fig. 1 and Fig. 2 show the effect of pre-treatment on rehydration ratio at different tray drying temperature and microwave power level, respectively. ANOVA were generated for all physico-chemical parameters (moisture content, drying rate, vitamin C and rehydration ratio) which were significant at 5 per cent level.

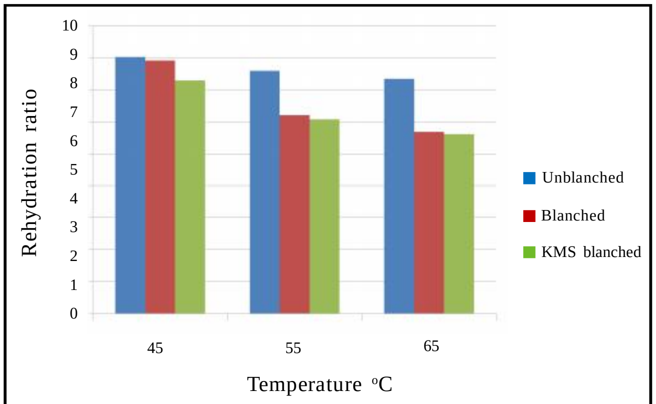

Fig. 1 : Effect of pre-treatment on rehydration ratio at different tray drying temperature

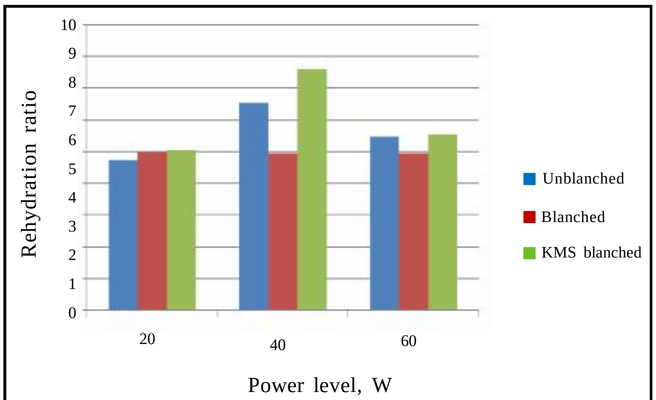

Fig. 2 : Effect of pre-treatment on rehydration ratio at different microwave power level

Conclusion:

Physico-chemical characteristics were studied for cauliflower slices at different pre-treatment and drying conditions. The initial moisture content of unblanched sample was found less than pre-treated samples at 45°C but at 55°C, the initial moisture content of unblanched, sample was observed highest (1538.14) in tray dryer. The initial moisture content of pre-treated samples had highest in microwave dryer in all power level. Drying rate of blanched sample had higher than other samples at 45°C and at 65°C but at 55°C drying rate of KMS blanched samples had highest in tray dryer while as in microwave, the drying rate of KMS blanched sample had highest at 20W, 40W but at 60W, drying rate of unblanched sample had highest. Moisture loss increased from cauliflower with increased in power of microwave and time of drying. The pre-treated samples taken shorter drying time than unblanched sample. Rehydration ratio was found acceptable in microwave for those samples which were dried at 40W with KMS blanched sample. Rehydration ratio of KMS blanched samples were found 5.056, 7.622 and 5.566 at 20, 40 and 60 W, respectively. Rehydration ratio of unblanched sample was found acceptable (8.024) in tray dryer which was dried at 45°C. Ascorbic acid content was found acceptable at 20W KMS blanched sample had highest ascorbic acid content (200mg/100g) dried by microwave. Ascorbic acid content at 45°C KMS blanched sample had highest (366.67 mg/ 100g) and it was acceptable. Microwave power drying was found most suitable than tray drying of KMS blanched cauliflower slices.

Authors' affiliations:
Devendra Kumar, Baba Saheb Dr. Bhim Rao Ambedkar College of Agricultural Engineering and Technology, **Etawah (U.P.) India**

■ REFERENCES

Gustavo, Barbosa-Canovas, V., Juan, J., Fernandez-Molina, Stella, M., Alzamora, Maria, S., Tapia, Aurelio lopez-malo and Jorge, Welti Chanes (2003). Handling and preservation of fruits and vegetables by combined methods for rural areas, Technical Manual FAO agricultural Services Bulletin-149.

Jayaraman, K.S. (1998). Development of intermediate moisture tropical fruit and vegetables products: Technological problems and prospects, In C.C. seow, (Ed) *Food preservation by moisture control*, (pp: 175-197). London: Elsevier Applied science Publishers.

Jayarman, J.M. (1982). Dchydration of potato-II, Osmotic concentration and effect on air drying behaviour. *J. Food Technol.*, **17** : 387.

Kanwade, V.L. Maharaj, N. and Kmbhar, B.K. (1995). Drying behaviour of peas in fluidized bed, *Indian Food Packer,* **49**(6): 25-35.

Krokida, M.K. and Maroulis, Z.B.(2001). Structure properties of dehydrated products drying rehydration, *Internat. J. Food Sci. & Tech.*, **36** : 529-538.

Lewicki, P.(1998). Effect of pre-drying treatment drying and rehydration on plant tissue properties; A review. *Int. J. Food,* **1** (1) : 1-22.

Lund, D.B., Bruline, S. and Larer, M.E. (1972). Internal temperature distribution during individual quick blanching. *J. Food Sci.,* **37**:167-170.

Mazza, G. (1983). Dehydration of carrots. Effects of pre-drying treatments on moisture transport and product quality. *J. Food Technol.,* **18** : 113-123.

Mudgal, V.D. and Pandey, V.K. (2007). Dehydration characteristics of cauliflower, *Internat. J. Food Engg.,* **3** (6) : 1556-3758.

Mudgal, V.D. and Pandey, V.K. (2008). Effect of pretreatment on Dehydration of cauliflower. *J. Food Sci. & Technol.,***45** (5) : 426-429.

Nath, N. and Katara, D.K. (1985). Effect of pre-treatments on quality of dried potato cubes. *Indian Food Packer,* **39** (5): 23-26.

National Horticulture Board (2016). *Indian Horticulture Database, Govt. of India*, Gurugram (Haryana) India.

Neelavathi, P., Venkatalakshmi, P. and Brindha, P. (2013). Antivacterial activities of aqueous and ethanolic extracts of *Terminalia catappa* leaves and bark against some pathogenic bacteria. *Internat. J. Pharm. Pharm. Sci.,* **5** (1): 114-120.

Premi, B.R., Sethi, V. and Saxena, D.B. (1997). Studies on identification of white specks in cured aonla (*Emblica officinalis* Gaertn.) fruits. Division of Fruits and Horticultural Technology, IARI, New Delhi and Division of Agriculture Chemicals. IARI New Delhi, India.

Radhakrishnan, K.L. (1999). Editorial. *India Food Packer,* **53** (3) : 4-5.

Sehgal, S. (1999). *Indian economic data*. Shivam Offset Press, Naraina, New Delhi, India.

Sutar, P.P. and Prasad, S. (2008). Microwave drying technology-recent developments and R and D needs in India. In Proceedings of 42nd ISAE Annual Convention, 13 Feb.2008.

Vora, P., Senecal, A. and Schaffner, D.W. (2003). Survival of *Staphylococcus aureus*ATCC13565 in intermediate moisture foods is highly variable. *Risk Analysis*, **23**(1) : 229.

Wang, N. and Brennan, J.G. (1995). A mathematical model of simultaneous heat and moisture transfer during drying of potato. *J. Food Engg.*, **24** : 47–60.

Yadav, S.K. and Sehgal, A. (1997). Effect of home processing on ascorbic acid and beta carotene content of bathua (*Chenopodiun athbum*) and fenugreek (*Trigonelia foenumgraecum*) leaves. *Plant Food Hum. Nutr.,* **50**: 239-247.

12th Year
★★★★★ of Excellence ★★★★★