Effect of pre-treatment and storage on moisture content and total plate count of potato powder prepared from different potato varieties

AK GUPTA*

AICRP on Post Harvest Engineering and Technology, College of Agricultural Engineering Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur 482004 Madhya Pradesh, India
*Email for correspondence: write2drakg@gmail.com

 Received: 04.06.2023/Accepted: 02.07.2023

ABSTRACT

For the preparation of potato powder, potatoes of three varieties (Kufri Chipsona-2, Kufri Chipsona-1 and Kufri Bahar) 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 2 mm thick slices using hand-operated stainless steel slicer. The slices were pre-treated with 2 ppm solution of potassium metabisulphite (KMS) by dipping for 15 minutes. These were also pre-treated with hot water blanching at 80-85°C temperature for 3 minutes. Slices were dried in a tray drier at 50, 60, 70 and 80°C. After drying, samples were cooled at room temperature and ground to make potato powder for further study. The moisture content of flour prepared from KMS-treated slices was found to be little higher as compared to the flour of hot water-blanched slices. The moisture content of flour increased significantly during storage, irrespective of pre-treatment and potato cultivars. The total plate count (TPC) of the flour prepared from KMS-treated slices was found to be lower than those of the hot water-blanched and control slices.

Keywords: Potato powder; pre-treatment; storage; moisture; TPC; blanching

INTRODUCTION

Potato flour, also known as potato meal, is the oldest potato product. It is highly concentrated and nutritious flour, ground from the pulp of the cooked potato. It is produced commercially using drum drying and spray drying of pre-cooked mashed potatoes (Pyler 1973, Willard 1975). Potato flour has higher level of fibre content than refined wheat flour, maize meal and rice flour but lower level of fibre than cassava and yam flour (Woolfe 1987). Potato flour is a good source of protein, comparable to wheat and slightly better than rice on the dry weight basis (Woolfe 1987, Kulkarni et al 1988, Kabira et al 1990). The flour embodies all the chemical constituents of potato, retaining all the minerals. The flour is heavy and thus comparatively small quantities are required in baked products. The flour is also used as thickening agent in soups.

The simplest and widely used procedure for the preparation of potato flour is dehydrating potatoes in the form of slices and then grinding them to make flour (Srivastava et al 1973). For large scale production, a faster way of drying the slices is by using a kiln or a flow drier (Choudhuri et al 1963). Another method of preparation of potato flour is to dry mashed cooked potatoes on a roller drier. Pant and Kulshrestha (1995) prepared potato flour from six potato varieties by pressure cooking the potatoes at 10 lb/cubic inch for 22 min, cooling under running water to room temperature within three minutes and further drying in a cabinet drier at 60°C.

Potato flour, commonly used in baking industry, is prepared by dehydration of peeled and cooked potatoes on a single drum drier equipped with applicator rolls. The thin, dried sheet of potato solid is then ground to the desired fineness. The single drum drier is one of the most efficient means of dehydrating potatoes. By spreading the mash into a fine sheet, extremely rapid evaporation of water can be achieved. Potato flour is used by the baking industry and is incorporated in the baking of bread to retain its freshness. It also imparts a distinctive and pleasing flavour and improves toasting qualities. The generally accepted level of potato flour in the bread is 6 per cent (Willard and Hix 1987).

MATERIAL and METHODS

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 2 mm thickness slices using hand-operated stainless steel slicer. The slices were pre-treated with 2 ppm solution of potassium metabisulphite (KMS) by dipping for 15 minutes. These were also pre-treated with hot water blanching at 80-85°C temperature for 3 minutes. After pre-treatment, slices were spread over the blotting paper to remove surface moisture for drying experiments. Drying of potato slices was done in a tray drier. At the end of drying, samples were cooled at room temperature and ground to make potato flour for further study. The dried potato slices were ground with the help of Willey mill. The ground samples were sieved to determine the average particle size as suggested by Sahay and Singh (1994).

The flow chart of the process of preparation of potato flour is as below:

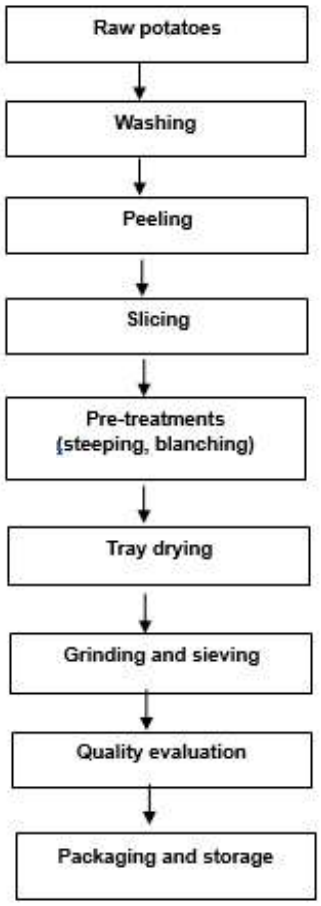

Fig 1. Flow chart of the process of preparation of potato flour

RESULTS and DISCUSSION

Effect of storage period on moisture content of potato flour

The data given in Table 1 show that in Kufri Chipsona-2, the initial moisture content of the potato flour made from hot water-blanched slices was 5.10, 4.92, 4.61 and 4.39 per cent (wb), from KMS-treated slices was 5.22, 4.91, 4.63 and 4.44 per cent (wb) and from untreated slices was 4.92, 4.53, 4.45 and 4.22 per cent (wb) dried at 50, 60, 70 and 80°C temperature respectively. After 30 days of storing, the moisture content of the potato flour made from hot water-blanched slices was 5.32, 5.25, 5.15 and 5.02 per cent (wb), from KMS-trated slices was 5.39, 5.30, 5.22 and 5.15 per cent (wb) and from untreated slices was 5.22, 4.85, 4.76 and 4.51 per cent (wb) dried at 50, 60, 70 and 80°C temperature respectively. After 60 days of storing, the moisture content of the potato flour made from hot water-blanched slices was 5.75, 5.62, 5.48 and 5.32 per cent (wb), from KMS-trated slices was 5.81, 5.73, 5.52 and 5.47 per cent (wb) and from untreated slices was 5.52, 5.22, 5.08 and 4.92 per cent (wb) dried at 50, 60, 70 and 80°C temperature respectively.

In Kufri Chipsona-1 (Table 2), the initial moisture content of the potato flour made from hot water-blanched slices was 5.21, 5.05, 4.85 and 4.45 per cent (wb), from KMS-trated slices was 5.37, 5.28, 5.12 and 5.03 per cent (wb) and from untreated slices was 5.16, 5.05, 5.00 and 4.93 per cent (wb) dried at 50, 60, 70 and 80°C temperature respectively. After 30 days of storing, the moisture content of the potato flour made from hot water-blanched slices was 5.45, 5.32, 5.23 and 5.15 per cent (wb), from KMS-trated slices was 5.42, 5.39, 5.29 and 5.18 per cent (wb) and from untreated slices was 5.22, 5.11, 5.08 and 5.02 per cent (wb) dried at 50, 60, 70 and 80°C temperature respectively. After 60 days of storing, the moisture content of the potato flour made from hot water-blanched slices was 5.82, 5.71, 5.52 and 5.41 per cent (wb), from KMS-trated slices was 5.96, 5.78, 5.65 and 5.51 per cent (wb) and from untreated slices was 5.38, 5.21, 5.17 and 5.13 per cent (wb) dried at 50, 60, 70 and 80°C temperature respectively.

In Kufri Bahar (Table 3), the initial moisture content of potato flour made from hot water-blanched slices was 5.31, 5.15, 4.92 and 4.53 per cent (wb), from KMS-trated slices was 5.15, 5.10, 4.62 and 4.61 per cent (wb) and from untreated slices was 5.36, 5.13,

Table 1. Changes in moisture content of flour prepared from potato (Kufri Chipsona-2) slices during storage

Storage period (days)	Moisture content (% wb) at (°C)			
	50	60	70	80
Hot water-blanched slices				
0	5.10 ± 0.10	4.92 ± 0.07	4.61 ± 0.04	4.39 ± 0.03
30	5.32 ± 0.08	5.25 ± 0.03	5.15 ± 0.03	5.02 ± 0.08
60	5.75 ± 0.10	5.62 ± 0.02	5.48 ± 0.03	5.32 ± 0.04
KMS-treated slices				
0	5.22 ± 0.06	4.91 ± 0.02	4.63 ± 0.04	4.44 ± 0.03
30	5.39 ± 0.04	5.30 ± 0.03	5.22 ± 0.04	5.15 ± 0.04
60	5.81 ± 0.05	5.73 ± 0.04	5.52 ± 0.04	5.47 ± 0.03
Untreated slices				
0	4.92 ± 0.06	4.53 ± 0.02	4.45 ± 0.04	4.22 ± 0.03
30	5.22 ± 0.04	4.85 ± 0.03	4.76 ± 0.04	4.51 ± 0.04
60	5.52 ± 0.05	5.22 ± 0.04	5.08 ± 0.04	4.92 ± 0.03

	Hot water-blanched slices		KMS-treated slices		Untreated slices	
	$CD_{0.05}$	SEm±	$CD_{0.05}$	SEm±	$CD_{0.05}$	SEm±
Storage	0.0434	0.0148	0.0337	0.0115	0.1122	0.0382
Temperature	0.0501	0.0171	0.0389	0.0132	0.1295	0.0441
Storage × Temperature	0.087	0.0296	0.0670	0.0229	0.2240	0.0765

Table 2. Changes in moisture content of flour prepared from potato (Kufri Chipsona-1) slices during storage

Storage period (days)	Moisture content (% wb) at (°C)			
	50	60	70	80
Hot water-blanched slices				
0	5.21 ± 0.04	5.05 ± 0.03	4.85 ± 0.06	4.45 ± 0.04
30	5.45 ± 0.04	5.32 ± 0.04	5.23 ± 0.05	5.15 ± 0.05
60	5.82 ± 0.06	5.71 ± 0.04	5.52 ± 0.04	5.41 ± 0.03
KMS-treated slices				
0	5.37 ± 0.04	5.28 ± 0.05	5.12 ± 0.10	5.03 ± 0.03
30	5.42 ± 0.04	5.39 ± 0.04	5.29 ± 0.04	5.18 ± 0.03
60	5.96 ± 0.03	5.78 ± 0.04	5.65 ± 0.05	5.51 ± 0.04
Untreated slices				
0	5.16 ± 0.04	5.05 ± 0.05	5.00 ± 0.10	4.93 ± 0.03
30	5.22 ± 0.04	5.11 ± 0.04	5.08 ± 0.04	5.02 ± 0.03
60	5.38 ± 0.03	5.21 ± 0.04	5.17 ± 0.05	5.13 ± 0.04

	Hot water-blanched slices		KMS-treated slices		Untreated slices	
	$CD_{0.05}$	SEm±	$CD_{0.05}$	SEm±	$CD_{0.05}$	SEm±
Storage	0.0355	0.0121	0.0404	0.0138	NS	0.0492
Temperature	0.0410	0.0140	0.0466	0.0159	NS	0.0568
Storage × Temperature	0.071	0.0242	0.081	0.0275	NS	0.0985

Table 3. Changes in moisture content of flour prepared from potato (Kufri Bahar) slices during storage

Storage period (days)	Moisture content (% wb) at (°C)			
	50	60	70	80
Hot water-blanched slices				
0	5.31 ± 0.02	5.15 ± 0.05	4.92 ± 0.03	4.53 ± 0.03
30	5.49 ± 0.04	5.38 ± 0.04	5.31 ± 0.04	5.22 ± 0.04
60	5.96 ± 0.06	5.78 ± 0.03	5.63 ± 0.04	5.49 ± 0.01
KMS-treated slices				
0	5.15 ± 0.03	5.10 ± 0.03	4.62 ± 0.05	4.61 ± 0.05
30	5.55 ± 0.05	5.47 ± 0.04	5.39 ± 0.03	5.28 ± 0.07
60	6.02 ± 0.03	5.84 ± 0.04	5.72 ± 0.03	5.57 ± 0.06
Untreated slices				
0	5.36 ± 0.03	5.13 ± 0.03	4.75 ± 0.05	4.55 ± 0.05
30	5.42 ± 0.05	5.33 ± 0.04	5.27 ± 0.03	5.21 ± 0.07
60	5.77 ± 0.03	5.54 ± 0.04	5.43 ± 0.03	5.35 ± 0.06

	Hot water-blanched slices		KMS-treated slices		Untreated slices	
	$CD_{0.05}$	SEm±	$CD_{0.05}$	SEm±	$CD_{0.05}$	SEm±
Storage	0.0326	0.0111	0.0366	0.0125	0.0622	0.0212
Temperature	0.0377	0.0128	0.0423	0.0144	0.0718	0.0245
Storage × Temperature	0.065	0.0222	0.073	0.0250	0.124	0.0424

4.75 and 4.55 per cent (wb) dried at 50, 60, 70 and 80°C temperature respectively. After 30 days of storing, the moisture content of the potato flour made from hot water-blanched slices was 5.49, 5.38, 5.31 and 5.22 per cent (wb), from KMS-trated slices was 5.55, 5.47, 5.39 and 5.28 per cent (wb) and from untreated slices was 5.42, 5.33, 5.27 and 5.21 per cent (wb) dried at 50, 60, 70 and 80°C temperature respectively. After 60 days of storing, the moisture content of the potato flour made from hot water-blanched slices was 5.96, 5.78, 5.63 and 5.49 per cent (wb), from KMS-trated slices was 6.02, 5.84, 5.72 and 5.57 per cent (wb) and from untreated slices was 5.77, 5.54, 5.43 and 5.35 per cent (wb) dried at 50, 60, 70 and 80°C temperature respectively.

The moisture content of flour decreased significantly with increase in tray drying temperature. The potato slices dried at higher temperature acquired lower values of final moisture content irrespective of the variety and pre-treatment. It is well known fact that the water vapour pressure of the ambient air reduces as the temperature increases. The vapour pressure difference between the moisture present in the potato slices and in the air was higher at higher drying temperature as compared to the lower drying temperature. The moisture content of the flour prepared from KMS-treated slices was found to be little higher as compared to the hot water-blanched slices.

The moisture content of potato flour increased significantly during storage at 1 per cent ($p \leq 0.01$) level of significance, irrespective of potato cultivars and pre-treatments. The increase in moisture content of the flour during storage may be attributed to water vapour permeability of packaging material as the surrounding environment would have higher vapour pressure than the potato flour.

Effect of storage period on microbial load (TPC) of potato flour

The microbial load (TPC) of potato flour prepared from hot water blanching, KMS treatment and control slices of Kufri Chipsona-2, Kufri Chipsona-1 and Kufri Bahar was evaluated by the method suggested by Harrigan and McCance (1966).

Data given in Table 4 indicate that no microbial load was detected in all the three potato varieties at the initial stage or after 30 days of storage tray-dried at different temperatures irrespective of pre-treatments. However, after 60 days of storage, in case of Kufri Chipsona-2, the plate count decreased from 3.432 to 3.380×10^3 cfu/g in the flour made from water-

Table 4. Changes in total plate count of flour prepared from potato slices during storage

Storage period (days)	Total plate count (x 10^3cfu/g) at (°C)											
	Water-blanched slices				KMS-treated slices				Untreated slices			
	50	60	70	80	50	60	70	80	50	60	70	80
Kufri Chipsona-2												
0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
30	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
60	3.432	3.423	3.396	3.380	3.412	3.392	3.387	3.376	3.961	3.752	3.692	3.615
Kufri Chipsona-1												
0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
30	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
60	3.692	3.631	3.598	3.537	3.513	3.507	3.476	3.453	3.999	3.813	3.757	3.698
Kufri Bahar												
0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
30	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
60	3.714	3.692	3.683	3.652	3.702	3.682	3.662	3.603	4.076	3.987	3.856	3.777

ND: Not detected

blanched slices, from 3.412 to 3.376 × 10^3 cfu/g from KMS-treated slices and from 3.961 to 3.615 × 10^3 cfu/g from untreated slices. Similarly, in case of Kufri Chipsona-1, the microbial count decreased from 3.692 to 3.537 × 10^3 cfu/g in the flour made from water-blanched slices, from 3.513 to 3.453 × 10^3 cfu/g from KMS-treated slices and from 3.999 to 3.698 × 10^3 cfu/g from untreated slices. Similar was the trend in case of Kufri Bahar. In case of Kufri Bahar, the microbial count decreased from 3.714 to 3.652 × 10^3 cfu/g in the flour made from water-blanched slices, from 3.702 to 3.603 × 10^3 cfu/g from KMS-treated slices and from 4.076 to 3.777 × 10^3 cfu/g from untreated slices.

The increment in TPC values may be attributed to increase in moisture content of the potato flour during storage. It is the fact that increase in moisture content encourages the growth of microbes in the product. The study revealed that TPC of the flour prepared from KMS treatment was lower than that of hot water-blanched and control flour. Amongst three cultivars, the microbial load of potato flour prepared from Kufri Bahar was found to be higher than those of the flours prepared from Kufri Chipsona-2 and Kufri Chipsona-1 after storage of 60 days. This could be due to higher moisture content of potato flour of Kufri Bahar as compared to Kufri Chipsona-2 and Kufri Chipsona-1. It was also observed that KMS-treated flour was superior over hot water-blanched flour and control. It was thus concluded that the potato flour prepared from Kufri Chipsona-2 slices treated with KMS exhibited lowest microbial load after 60 days of storage at room temperature. The maximum TPC was observed in case of untreated flour of Kufri Bahar.

Pandey et al (2014) evaluated the physical and microbiological qualities just after preparation of potato powder at an interval of 15 days up to 90 days during storage at room temperature. The moisture content of powder decreased slowly with increase in drying time. Moisture content increased during storage. The powder dried at 60°C had higher moisture content. The microbial load (TPC) increased during storage. The samples blanched with KMS had the lower values of TPC than the samples blanched with hot water.

Misra and Kulshreshtha (2002) reported that the microbial count of potato flour prepared from three potato varieties namely K Sutlej, K Ashoka and OP-1, stored up to 6 months under room and refrigerated temperature, showed that variety OP-1 had the lowest (1.65 × 10^3) bacterial count which differed significantly ($\leq$0.05) from varieties K-Sutlej (1.76 × 10^3) and K-Ashoka (1.74 × 10^3). An increasing trend in total bacterial count with increase in storage time was observed in all the three varieties.

CONCLUSION

The initial moisture content of potato flour prepared from slices dried at higher temperature was found to be lower. The moisture content of flour prepared from KMS-treated slices was found to be little higher as compared to that of hot water-blanched

slices. During storage, the moisture content of all the samples increased significantly.

The total plate count of the flour prepared from KMS-treated slices was found to be lower than that of hot water-blanched and control slices. Amongst all the three cultivars, the microbial load of potato flour prepared from Kufri Bahar was found to be higher than that of Kufri Chipsona-2 and Kufri Chipsona-1 slices after 60 days storage. The total plate count of all the samples increased with storage period irrespective of tray-drying temperature. The results also revealed that KMS-treated flour was found to be superior over the hot water-blanched and control flour. The TPC of the flour prepared from KMS treatment was found to be lower than that of hot water-blanched and control slices.

REFERENCES

Choudhuri RNR, Joseph AA, Joseph K, Rao MN, Swaminathan M, Sreenivasan A and Subrahmanyan V 1963. Preparation and chemical composition of potato flour from some varieties of potato. Food Science **12:** 251-253.

Harrigan WF and McCance EM 1966. Laboratory methods in microbiology. Volume 54, Academic Press, Cambridge, 970p.

Kabira, JN, Imungi, JK, Haas J and Amado R 1990. Proximate composition, mineral content and protein nutritional quality of potato flour from solar-dried potato slices. In: Production, post-harvest technology and utilization in the warm tropics (N Govindan, MHR Julien, GLT Hunt, and LJC Auprey, Eds), Mauritius Sugarcane Industry Research Institute, Reduik, Mauritius, pp 142-148.

Kulkarni KD, Kerure YE and Kulkarni DN 1988. Evaluation of potato cultivars for flour production. Beverage and Food World **8:** 214-218.

Misra A and Kulshrestha K 2002. Effect of storage on microbial safety of potato flour. Journal of Food Science and Technology – Mysore **39(5):** 517-519

Pandey HS, Nayak VK and Pisalkar P 2014. Evaluation and quality characteristics of potato powder. International Journal of Processing and Post Harvest Technology **5(1):** 12-15.

Pant S and Kulshreshtha K 1995. Physical characteristics of potato flour made from six varieties of potato. Journal of Food Science and Technology **32(1):** 71-73.

Pyler EJ 1973. Baking science and technology. Vol 1, 2nd Edn, Siebel Publishing Company, Chicago, United States.

Sahay KM and Singh KK 1994. Unit operations of agricultural processing. Vikas Publishing House Private Limited, New Delhi, India, 340p.

Srivastava SNS, Singh M and Verma SC 1973. Sun-dry your surplus potatoes. Indian Farming**17:** 16-17.

Willard M 1975. Potato flour. In: Potato processing, 3rd Edn (WF Talburt and O Smith, Eds), AVI Publishing Company, Inc, Westport, Connecticut, USA, pp 563-578.

Willard M and Hix VM 1987. Potato flour. In: Potato processing, 4th Edn (WF Talburt and O Smith, Eds), Van Nostrand Reinhold Company, New York, USA, pp 665-680.

Woolfe JA 1987. The potato in the human diet. Cambridge University Press, Cambridge, London, UK, pp 118-152.