International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(6): 253-255

Received: 10-09-2017
Accepted: 11-10-2017

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Storage studies on potato products of Jammu region influenced by packaging and chemical treatments

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Abstract
Potato is the vegetable crop and can be used for preparing various food products like chips, cubes, flour, slices, french fries, granules, powder etc. India having tropical climatic conditions the packaging and storage of above processed products for longer period is posing a big problem. An investigation was carried out to study the effect of different packaging and anti-browning chemical pre-treatments on storability of potato products. Results indicated that potato slices and cubes pre-treated with citric acid 0.10% + KMS 0.5% and packed in 300 gauge polyethylene bag had longer storability and good organoleptic qualities followed by the products of same pre-treatment packed in 200 gauge polyethylene bags.

Keywords: Slices, packaging, sensory quality, storage, ambient condition

Introduction
India is the fourth largest potato growing country ranking third in production. Potato is one of the most important crops grown in the world having high productivity and supplementing food requirements of the people. India having tropical climatic conditions, lot of produce and processed products are wasted for want of good packaging and storage. The technique of packaging of fruits and vegetables is to assemble the produce in convenient units for protecting them from deterioration during their handling from the farm gate to consumer's plate (Abbas, 2012) [1]. Use of plastics is very pronounced method for packaging of perishables and processed products with a purpose to extend their storage life. The effective role of modified atmospheric packaging (MAP) by us of plastic film is for maintaining the quality of the produce, suppressing post-harvest pathogens. Plastic packaging also helps in minimizing the cost of packaging material and makes the whole process less dependent on scarce materials like wood etc. The processed potato products like slices and cubes are very much prone to non-enzymatic browning when they are exposed to air and this problem is more common during sun drying of potato products. To overcome these problems, efforts were made to study the effect of different anti-browning chemicals and packaging's with different gauges of plastics on storage quality of potato products viz slices and cubes.

Materials and Methods
An experiment was carried out on effects of low cost anti-browning chemicals and different gauges of polyethylene packages on storage quality of potato. Potato tubers of variety Kufri Sindhuri was procured from Bari Brahmana District Samba, Jammu then selected washed and peeled by using a simple hand peeler. Potato slices of 1.5 mm thickness were prepared with a hand slicer and for cubes peeled tubers were cut into 0.5cm cubes. These products were treated with various combinations of chemicals and packaging's and implemented the treatments as follows:

Table 1

S No.	Treatment
T_1	Slices treated with citric acid (0.10%) + KMS (0.5%) + packed in 100 gauge polyethylene bag.
T_2	Slices treated with citric acid (0.10%) + KMS (0.5%) + NaCl (2%) + packed in 100 gauge polythene bag.
T_3	Slices treated with citric acid (0.10%) + KMS (0.5%) + packed in 160 gauge polythene bag.
T_4	Slices treated with citric acid (0.10%) + KMS (0.5%) + NaCl (2%) + packed in 160 gauge polythene bag.
T_5	Slices treated with citric acid (0.10%) + KMS (0.5%) + packed in 200 gauge polyethylene bag.
T_6	Slices treated with citric acid (0.10%) + KMS (0.5%) + NaCl (2%) + packed in 200 gauge polythene bag.

The detailed observations on change in PLW, and biochemical parameter (TSS, Total Sugar, Reducing Sugar, Ascorbic acid, Acidity, Starch and Sensory qualities) were recorded at the interval of five days during entire storage period. Reducing sugar, Total Sugar and Starch were estimated by the method suggested by AOAC (1995) [4] and the total acidity and ascorbic acid were estimated by titration methods. Sensory evaluations were done by appointing a panel of judges on a 9 point hedonic scale.

Results and Discussion

Results revealed that there was a gradual increase in physiological weight loss with increased duration of storage. Among the packaging material used, the potato products packed in polyethylene bags of 300 gauge recorded least PLW followed by the products in 200 gauge polypacks. However, highest PLW was recorded with the potato products packed in 160 gauge polypacks due to higher permeability to moisture loss (Kaul, 2010) [6] opined that, the general loss of material in cell structure during the process of respiration is responsible for loss of weight of the products. Further the least PLW% in polypacks of higher gauge (300) might be due to low permeability nature to loss of moisture (Dev and Lal, 2008) [5].

Biochemical Changes

In general all the biochemical substrates present in the potatoes were decreased during storage. The loss of these biochemical constituents were more in products packed in lower gauge polyethylene bags due to more oxidation and dehydration and utilization of these substrates during respiration process. The loss in acidity might be due to activity of carboxylase and some enzymes which are closely associated with respiration rate. The total soluble solids in potato products were decreased with increased duration of storage. The potato products with treatment T_3 and T_4 could maintain significantly higher levels of TSS even up to the end of storage period. However, significantly lower in TSS was observed with the products in T_1 at the end of storage. This might be due to the slower rate of respiration leading to less utilization of soluble solids. Similarly the ascorbic acid content was reduced as the days of storage progressed. The ascorbic acid was found to be one of the anti-browning chemical used in the treatment and showed higher retention of ascorbic acid with the products in T_4 and T_3 as compared to the products in other treatment. This might be due to less oxidative destruction of ascorbic acid in presence of molecular oxygen by ascorbic acid oxidase. Kazami *et al*. (2001) [7] reported 74% losses of ascorbic acid in potato granules under sunlight. Similarly the sugar content of potato is of considerable importance in relation to processed products especially for fried ones. The chip colour is dependent on the reaction between reducing sugars and free amino acids on exposure to higher temperature. In the present investigation the initial reducing sugar content of potato was 0.355%. It significantly reduced as the storage durations progressed (Abong, 2011) [2].

Among the treatments imposed, the potato products treated with treatment T_4 recorded least total and reducing sugar with highest starch content at the end storage period. However, maximum content of reducing sugar and total sugar were recorded in products with treatments T_1 and T_5. The reduction in sugar in above best treatment might be due to low activity of enzyme invertage. Similar results were also reported by Alkesh *et al*. (2001) [3]. The starch content in products varied with treatments. Among the treatments T_4 maintained higher starch level followed by T_3 and lowest starch content was found in T_1 and T_2 at the end of storage. Further the potato products packed in alumminum foil got rotted early; there by the potato products had poor scorings in all organoleptic readings. This was due to high moisture content in the product before packaging and exclusive depletion of O_2 inside the package, which lead to anaerobiosis accompanied by undesirable metabolic reactions such as tissue breakdown and development of off-flavor (Mehta and Singh 2004, Kumar and Ezekiel 2005) [12, 9].

Chemical characteristics of slices and cubes as influenced by anti-browning chemicals and packaging at browning inhibition. Both the products treated with combinations of chemicals showed acceptable quality with regard to browning inhibition as compared to the products without any chemical treatments. Among the treatments imposed the potato products with T_4 showed best result by reducing the non enzymatic browning. The results are in conformity with the facts obtained by Patra *et al*. (2007) [13] and observed that, the respiration in these pre-treated potatoes were lower and maintained light colour in modified atmospheric packaging. The Citric acid exerted its inhibitory effect on polyphenol oxidase by lowering the *p*H as well as by chelating the copper at the active site of the enzyme. Because of this action less browning was observed in products packed in polyethylene pouches in combination with above chemical treatments Sandhu and Parhawk (2002) [14]. However, the potato products packed without any chemical treatments recorded significantly higher spoilage as the polyethylene bag created a favorable climatic condition for micro-organisms and spoiled the entire content of package with off flavour (Lindsay *et al*., 2005) [10].

Sensory Evaluation

Among the different gauges of polyethylene used the potato products packed in polyethylene bags of lesser gauges (100,160, and 200) had poor colour and organoleptic qualities as compared to higher gauge polybags (300 gauges) due to non-enzymatic browning. This could be due to inadequate SO_2 levels retained in the packs of lower gauge LDPE film. The results corroborates with the facts obtained by Kolawole *et al*. (2011) [8] and Mathles *et al*. (2008) [11]. Further, the slices and cubes treated with (T_4) combination of treatments (Citric acid 0.10% + KMS 0.5% and packed in 300 gauge polyethylene bag) had showed less non enzymatic browning and higher scorings with regard to colour, texture and overall acceptability, as compared to those packed in lower gauge polyethylene bags and aluminium foil, Abong *et al*. (2011) [2] reported that product that is exposed to more than 52% of RH became organoleptically unacceptable as it had become soggy and tough.

Microbial Infection

The slices and cubes kept in various gauges of polyethylene bags under ambient temperature were infected by the microbes like, *Aspergillus niger Rhizopus* and *Scelerotium* bodies. However, the infection percentage was less in potato slices and cubes treated with anti-browning chemicals such as citric acid (0.10%) + KMS (0.5%) and packed in poly bags of 300 gauge (T_4). The less microbial infection was observed in T_4 due to low permeability to atmospheric moisture and influence of applied acids in those treatments in inhibiting substrate transpiration by alteration of cell membrane permeability. Similar results were obtained by Kaul (2010) [6]

when potato products pre-treated with citric acid mixture and packed in polyethylene packages.

Conclusion

Potato is a wholesome food and can be used for preparation of various food products like chips, cubes, flour, slices, French fries, granules, powder etc. India having tropical climatic conditions, lot of produce and processed products are wasted for want of good packaging and storage. From the present investigation it is concluded that the locally available anti browning agents like citric acid, NaCl, KMS in combination with higher gauge polypacks (300 gauge) helped in reducing browning as compared to lower gauge polyethylene bags. The respiration in these pretreated potatoes was lowered and maintained light colour in modified atmospheric packaging. The citric acid exerted its inhibitory effect on polyphenol oxidase by lowering the *p*H as well as by chelating the copper at the active site of the enzyme. Because of this action less browning was observed in products packed in polyethylene pouches in combination with above chemical treatments. The less microbial infection was observed in T_4 due to low permeability to atmospheric moisture and influence of applied acids in those treatments in inhibiting substrate transpiration by alteration of cell membrane permeability.

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