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PHYSICAL CHARACTERISTICS OF MINIMALLY PROCESSED POTATOES AS INFLUENCED BY ANTIBROWNING CHEMICALS AND STORAGE TEMPERATURES

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ABSTRACT
The shelf life of minimally processed cut potatoes is limited by enzymatic browning that leads to a decrease in food quality. Use of different antibrowning chemicals and different storage temperatures can minimize the browning. The aim this work was to standardize the best chemical treatment (NaCl at 1% & 2% and citric acid at 0.25% & 0.5%) and storage temperature (0, 4 and 8^{o}C) for reducing the postharvest browning and keeps good physical characteristics in minimally processed potato up to the end of shelf life. Among all the combinations, the potato cubes treated with 0.5% citric acid and stored at 0^{o}C recorded longer storability by keeping the potato cubes with minimum physiological loss in weight (2.04 %), better firmness (8.23 kg cm^{-2}) and low spoilage (4.9%) and highest shelf life of 31 days of minimally processed potato cubes at the end of storage period followed by the potato cubes treated with 0.25% citric acid stored at 0^{o}C.

KEY WORDS: Minimally processed potatoes, antibrowning chemicals and physical characteristics.

INTRODUCTION

Potato (*Solanum tuberosum* L.) belongs to the family Solanaceae and it is one of the unique most potential crops having high productivity, supplementing major food requirement in the world. It is rich in carbohydrates, proteins, phosphorous, calcium, vitamin-C and carotene and high protein calorie ratio. Potato processing proves to be an important option for India's becoming self reliant in sustaining the food and nutrition. The most popular processed products of potato are chips, french fries, powder, cubes, slices and starch. Minimally processed vegetables have become widely accepted in restaurants, catering services, salad bars and consumer packs for home. Application of partial processing increases perishability due to increased metabolic activities and decompartmentalization of enzymes and substrates. This may cause browning, sofenting and off-flavour development (Watada *et al.*, 1990.)

The most important quality defect in some fresh-cut fruits and vegetables is enzymatic browning caused by oxidation of phenolic compounds by polyphenol oxidases in the presence of oxygen. Potatoes are extremely sensitive to enzymatic browning. Sapers *et al.*, (1995) studied the inhibition of browning in pre-peeled potatoes through antibrowning chemical treatments such as use of ascorbic acid/citric acid solutions and vacuum and pressure infiltration. Research has also been done on MAP (including vacuum packaging) of fresh-cut potatoes with different treatments. About two week shelf-life for fresh-cut potatoes could be achieved by vacuum packaging after treating potatoes with antibrowning agents (Anderson and Zapsalis, 1957; O'Beirne and Ballantyne, 1987). Present work was carried out to standardize the best chemical treatment and storage temperature for reducing the postharvest browning in minimally processed potato.

MATERIALS & METHODS

Potato tubers of variety Kufri jyothi was selected washed and peeled by using a hand peeler. Potato cubes of 2 cm^{3} were prepared with a potato cutter. These potato cubes were first treated with 2 % potassium metabisulphite for ten minutes, and then they were dipped in antibrowning chemical solutions for ten minutes. The cubes after treatment were shade dried for ten minutes to remove excess moisture adhering them and were stored at respective temperatures of 0^{o}C, 4^{o}C and 8^{o}C were observed for their shelf life using separate refrigerators were implemented the treatments as follows:

T_1– C_1S_1– Cubes treated with 2 % KMS + 1% NaCl + stored at 0^{o}C
T_2– C_1S_2– Cubes treated with 2 % KMS + 1% NaCl + stored at 4^{o}C
T_3– C_1S_3– Cubes treated with 1% NaCl + stored at 8^{o}C
T_4– C_2S_1– Cubes treated with 2% NaCl + stored at 0^{o}C
T_5– C_2S_2– Cubes treated with 2% NaCl + stored at 4^{o}C
T_6– C_2S_3– Cubes treated with 2% NaCl + stored at 4^{o}C
T_7– C_3S_1– Cubes treated with 0.25% Citric acid + stored at 0^{o}C
T_8– C_3S_2– Cubes treated with 0.25% Citric acid + stored at 4^{o}C
T_9– C_3S_3– Cubes treated with 0.25% Citric acid + stored at 8^{o}C
T_{10}– C_4S_1– Cubes treated with 0.5% Citric acid + stored at 0^{o}C
T_{11}– C_4S_2– Cubes treated with 0.5% Citric acid + stored at 4^{o}C
T_{12}– C_4S_3– Cubes treated with 0.5% Citric acid + stored at 8^{o}C

The detailed observations on change in physiological parameters *viz.*, Physiological loss in weight (PLW), change in colour, firmness, spoilage (%) and organoleptic score were recorded at the interval of every second day

during entire storage period. The potato cubes were assessed for change in colour at ambient and refrigerated temperatures following a subjective visual colour score.

Point/Score	Colour
1	No change
2	Light brown
3	Dark brown
4	Black

The organoleptic or the sensory evaluation of potato cubes was carried out by a panel of 5 judges following hedonic rating system for characters like aroma taste as per the score (5-1) described below (Sandhu and Parwhawk, 2002).

Point/Score	Quality
1	Very poor
2	Poor
3	Fair
4	Good
5	Excellent

RESULTS & DISCUSSION

There was a gradual increase in physiological weight loss with increased duration of storage. Among the chemical treatments and storage temperatures potato cubes treated with T_{10} (Cubes treated with 0.5% Citric acid + stored at 0^oC) recorded lower PLW, this might be due to reduced transpiration rate, respiration activity and reduced microbial growth with the influence of chemicals and low temperature storage. Low temperatures may reduce the respiration which in turn suppresses the metabolic activity (Subramanyan *et al.*, 1975).

Significant results were not found in colour change of potato cubes when treated with different antibrowning chemicals and storage temperatures. However lowest colour score was observed in the treatments when potato cubes treated with citric acid and stored at low temperature (0^oC). Low temperatures inhibits the activity of enzyme polyphenol oxidase activity thereby the surface discolouration is also inhibited. Citric acid had an ability to chelate metals such as copper and iron, and binding of these metal ions to limit the available ions which are necessary for poly phenol oxidase inactivation (Lee, 1991). The percent spoilage was increases with storage period, however less spoilage was observed when potato cubes were treated with T_{10} (Cubes treated with 0.5% Citric acid + stored at 0^oC) Spoilage was occurred in terms of colour change and microbial contamination. Less spoilage might be due to citric acid with low temperatures and pH reduces polyphenol oxidase activity. Thus acidification has been widely used for control of enzymatic browning particularly in processing of fruits. Lightly processed vegetables can be contaminated with many spoilage organisms including yeasts, mould and bacteria because of high moisture content. The aerobic conditions required for regular respiratory activity of the product. Anaerobic conditions or absence of oxygen could result in off- flavour development particularly in peeled potatoes and could facilitate growth and toxin production by microorganisms. Some of the bacteria that might be present including *Clostridium botulinum* and *Listeria monocytogenes* are pathogenic to consumer (Beirne, 1990). A decrease in firmness with increase in storage period was observed from the data. However, decrease in firmness was low in the treatment T_{11} (Cubes treated with 0.5% Citric acid + stored at 4^oC) might be due to acidification because of the presence of citric acid resulted in less microbial attack. The results are also in conformity with the fact obtained by Joshi and Nath (2002). They noticed that, the acid dipped potato chips retained their light yellow colour and crisp texture during storage because of less moisture in potato chips and lower values of sugars.

Highest organoleptic score (5) was maintained in the treatment T_{10} (Cubes treated with 0.5% Citric acid + stored at 0^oC) compared to the all other treatments. The higher score might be attributed to the fact that, cubes maintained good quality by avoiding the microbial infection, rotting, their by retained of good quality at the end of storage period. Hence the potato products which had less enzymatic discolouration on exposer to air by lowering pH and antifungal property by citric acid and KMS, maintained higher level of aroma and taste. Barwal *et al.* (2005) reported that, the cauliflower can be preserved by using different concentration and combination of salt like KMS and citric acid which scored better among the different treatments and maintained better physico-chemical, sensory qualities and checking microbial growth.

Significant differences were observed among different treatments. Maximum shelf life (31 days) was recorded in T_{10} (Cubes treated with 0.5% Citric acid + stored at 0^oC) which was on par with T_1, T_4 and T_6 (29, 30.33 and 30.33 days, respectively). Potatoes are extremely sensitive to enzymatic browning. Inhibition of browning by different antibrowning agents in combination with low temperature storage increases the shelf life. Similar results were obtained by Gunes and Lee (1997) who opined that shelf life of minimally processed potatoes treated with citric acid could be extended to nearly 3 weeks under refrigerated conditions. These findings were in accordance with Eleni and Theodoros (2011).

TABLE 1: Effect of antibrowning chemicals and storage temperature on physical characteristics of cubes at the end of storage

Treatment	PLW (%)	Change in colour	Spoilage (%)	Firmness (kg cm^{-2})	Shelflife (days)
T_1	3.56	2.00	5.13	6.96	29.00
T_2	3.67	2.33	22.86	8.30	14.00
T_3	3.66	3.00	28.97	7.90	14.00
T_4	3.29	2.00	5.800	7.93	30.33
T_5	3.42	2.66	11.36	8.50	17.00
T_6	3.54	2.33	27.76	7.93	14.00
T_7	2.49	2.00	5.43	7.96	30.33
T_8	2.57	2.33	10.50	8.60	20.00
T_9	2.57	2.33	25.33	8.30	18.00
T_{10}	2.04	2.00	4.90	8.23	31.00
T_{11}	2.14	2.00	10.00	9.13	29.00
T_{12}	2.40	2.33	21.43	8.50	17.66
C.D at 5%	0.058	NS	0.334	0.240	2.188
SE (m)±	0.020	0.333	0.114	0.082	0.745

CONCLUSION

Fresh cut potato cubes are a basic ingredient for ready to use vegetable and it is having increasing demand and success in the market. The shelf life of minimally processed cut potatoes is limited by enzymatic browning that leads to a decrease in food quality which implies spoilage. It is important to find a feasible anti-browning treatment as an alternative to browning. According to the results obtained in this study, it was concluded that potato cubes treated with 0.5% citric acid stored at 0^0C (T_{10}) had longer storability by maintaining good physical and sensory characters during storage with a shelf life of 31 days as compared to 0.25% citric acid, 1% and 2% NaCl in combination with storage temperatures 0, 4 and 8^0C.

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