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Effect of packaging and storage temperature on shelf-life of minimally processed onion (*Allium cepa* L.)

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ABSTRACT

Minimally processed onion is a ready-to-use onion product offering the consumer a fully usable commodity, without much change to freshness of the produce. Effect of packaging and storage temperature on shelf-life in minimally processed onion was studied. Packaging and temperature play an important role in determining shelf-life in minimally processed onion. Onion pieces approx. 8-10mm thick were cut with a plain, sharp knife and subjected to dip-treatment with the firming agent, calcium lactate (2%), for 5 minutes. The samples were surface-dried and packaged in polypropylene bags of size 250 X 125mm, of variable thicknesses (25, 50 or 75µm) and stored at low temperatures and high RH:8±1°C and 83±2% RH; 10±1°C and 82±2% RH; and, 12±1°C and 80 ±2% RH. It was found that onion cv. Arka Sona sliced with a plain, sharp knife, pre-treated with 2% calcium lactate, surface-dried and packaged in polypropylene bags sized 250X125mm (50µm thick), and stored at 8±1°C and 83±2% RH retained freshness and nutritive value, were microbially safe and acceptable, with a shelf-life of 14 days at storage.

Key words: Minimal processing, onion, calcium lactate, polypropylene bags, shelf-life

INTRODUCTION

Onion is the most important bulbous crop grown in India, besides garlic. Though it is a vegetable, onion also serves as a spice and provides an aromatic flavour to the dish. Onion is a basic flavouring agent / ingredient in the kitchen. When used as a vegetable or spice, it brings out the flavour of other dishes without overpowering them. Fresh onion has a pungent, persistent, even irritating taste; but, when sauted, onion becomes sweet and less pungent.

Minimally processed onion is a ready-to-use onion commodity which offers the consumer a fully usable product with high nutritive value and increased shelf-life without effecting much change in freshness of the produce. Use of fresh-cut onion saves labour and time, as, cutting onions is labour-intensive and time-consuming. Fresh-cut products are freshly cut, washed, packaged and held under low temperature. Even though minimally processed, these remain in a fresh state, ready to eat or cook.

Preparation of fresh-cut onion involves trimming, peeling, cutting, sanitizing and packing conveniently to offer the consumer 100% usable product, with high nutritive value and increased shelf life, without causing much change in freshness. These are prepared for restaurants and mass-dining functions such as marriages, parties and have gained popularity in urban India in the recent past. Due to urbanization and with most of the families having working women, lack of time for cutting onion for cooking is a constraint, and packaged onions fit this need perfectly. Mostly, minimally-processed vegetables are stored at low temperatures. Packaging and temperature play an important role in the shelf-life of minimally-processed vegetables. With this in view, studies on the effect of packaging and storage temperature on shelf-life in minimally processed onion were made.

MATERIAL AND METHODS

Onion cv. Arka Sona, grown at ICAR-Indian Institute of Horticultural Research, Bengaluru, India, was used in the study. Onion was harvested from the field, cured and sorted to remove injured bulbs, and to obtain bulbs of uniform size and colour. The onions were peeled and cut into pieces of approximately 10g each, thickness 8-10mm (approx.) using a sterilized, sharp stainless-steel knife.

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Onion pieces approx. 8-10mm thick were cut with a plain, sharp knife and subjected to dip-treatment with the firming agent, calcium lactate (2%), for 5 minutes. The samples were surface-dried and packaged in polypropylene (PP) bags of 250mm X 125mm size, differing in thicknesses, viz., 25µm, 50µm or 75µm thick, and stored at variable low temperatures: 8±1°C and 83±2% RH; 10±1°C and 82±2% RH; and, 12±1°C and 80 ±2% RH. Though the recommended storage temperature is 2-6°C, ready-to-use products are often stored at higher temperatures in normal retail-distribution (Carlin *et al*, 1990)

Subjective measurements such as visual quality (including freshness, browning, shelf-life decay, aroma and discoloration) measurements were made at regular intervals (every two days) to determine shelf-life of the sample. Discolouration, dryness and separation of rings indicated the end of shelf-life of a sample. Visual quality was studied as per Camelo and Cantwell (1999).

At end of the shelf-life for each sample, quality parameters such as weight-loss, moisture content, firmness, respiration rate, total and reducing sugars, pyruvic acid content, acidity and total soluble solids, were measured and analyzed. The best package and storage temperature combination, in terms of maximum shelf-life of minimally processed onion, was subjected to microbial analysis by the pour plate technique (Downes and Lto, 2001). Completely Randomized Design was used in all the experiments and data analyzed statistically using WASP 2.0 software.

RESULTS AND DISCUSSION

Effect of packaging and storage conditions on physic-chemical qualities in minimally processed onion at the end of storage

a) Shelf-life

Samples packed in polypropylene (PP) bags of 50µm thickness, stored at 8±1°C and 83±2% RH, showed lower dryness, intact rings and less browning at the end of the storage period (14 days) compared to samples packed in PP bags 25µm thick, which showed more browning, had detached rings (due to moisture-loss in the sample), whereas, spoilage occurred in samples packaged in 75µm PP bags, due to moisture condensation. In samples stored at 10±1°C and 82±2% RH, and, 12±1°C and 80 ±2% RH, shelf-life of the samples ended in 11 days and 8 days, respectively. However, as found in 8±1°C and 83±2% RH, observations made were similar in samples packaged in bags 25µm, 50µm or 75µm thick. This shows that lower storage-temperature extended the shelf-life of a product. Product degradation intensified with increase in storage temperature, as observed by Berno *et al* (2014) in stored minimally-processed onion.

Table 1. Effect of packaging and storage conditions on weight loss and firmness in minimally processed onion at the end of storage (14 days)

Treatment	Weight loss (%)			Firmness (kg_f/cm^2)		
	8±1°C	10±1°C	12±1°C	8±1°C	10±1°C	12±1°C
Initial	0	0	0	1.65	1.65	1.65
PP* bag 25µm	2.75	3.78	4.83	1.38	1.48	1.52
PP bag 50µm	2.51	3.35	4.79	1.50	1.59	1.64
PP bag 75µm	2.00	2.92	4.29	1.57	1.68	1.81
CD (1%)	0.56	NS	0.09	0.13	0.12	0.12

*PP: Polypropylene; NS: Non-significant

b) Weight-loss

At the end of storage period, samples packaged at 8±1°C had lower weight-loss in packages of all the three thicknesses (2.75% - 2.00%) compared to samples packaged at 10±1°C (3.78% - 2.92%) or 12±1°C (4.83% - 4.29%) (Table 1). Higher the storage temperature, greater the weight-loss in the sample, irrespective of thickness of the film. Moreover, it was observed that at all the three storage temperatures, samples packaged in PP bags 25µm thick showed greater dryness due to moisture-loss. Samples packaged in 75µm thick bags showed lower weight-loss due to higher film thickness. It was observed that samples packaged in 50µm thick bags superior owing to lower weight-loss and were fresher.

c) Firmness

It is observed from the Table 1 that firmness increased with increased storage temperature irrespective of packaging treatment. Firmness value was minimum at 8±1°C and 85% RH, which means that the sample had not lost its cell-integrity. Further, at 8±1°C and 85% RH, firmness value in 50µm was higher than in 25µm, and lesser than in 75µm PP bag throughout the storage period. However samples packaged in 50µm PP bag were preferred, based on lower dryness and presence of intact rings at the end of the storage period (14 days).

d) Biochemical parameters

Biochemical properties of minimally processed onion samples packaged in PP bags of different thicknesses were measured and are presented in Tables 2 and 3.

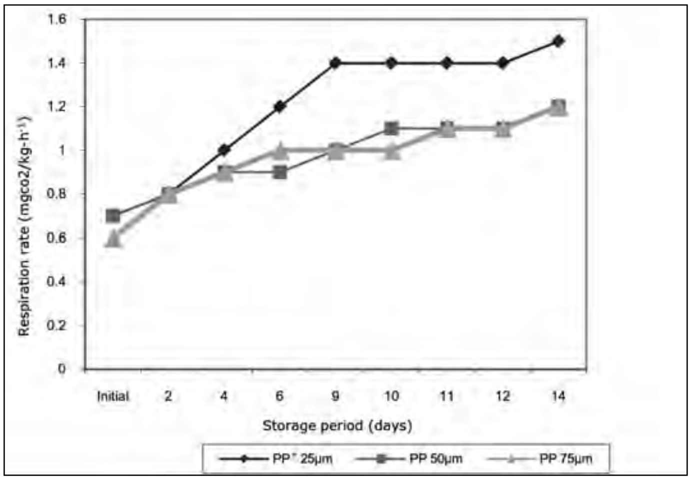
Samples packaged in PP bag of 50µm thickness had higher TSS and acidity to those packaged in PP bag of 25µm thickness (Table 2). Total sugar content in samples packaged in PP bags of all the thicknesses decreased compared to that in before bagging samples. Similar observations were made by Carlin *et al* (1990) in ready-to-use grated carrot during storage. Chunyang *et al* (2010) observed that onion slices packaged in 70µm thick, high-barrier film, had increased acidity and decreased total soluble solids (TSS) during storage. Decrease in TSS at the end of storage at 10°C in diced onion was observed by Hong *et al* (2000).

Pyruvic acid content was found to be high in samples packaged in PP bag 50µm thick (7.61µmol/g) at 8±1°C, compared to that in the other treatments (Table 3). Higher pyruvic acid content helped retain pungency in onion till the end of storage period (14 days). Pyruvic acid content was lower in samples stored at 12±1°C, perhaps due to their higher water content which, in turn, leached out pyruvic acid.

Total sugars were found to decrease with increasing storage temperature, irrespective of the treatment. As storage temperature increased, retention of nutrients decreased. Thus, samples packaged in 50µm thick polypropylene bags and stored at low temperature (8±1°C) were found suitable for retaining desirable biochemical qualities in minimally processed onion.

e) Respiration in minimally processed onion

Respiration rate in onion cv. Arka Sona samples packaged in polypropylene bags of 25, 50 and 75µm thickness, stored at 8±1°C and 83±2% RH, which recorded a maximum shelf-life of 14 days, was studied. In Fig. 1, it is observed that there is a steep increase in CO_2 evolution; after reaching a peak over a period of time, the increase was constant until the end of the storage period (14 days) in the sample in all the three types of package. Respiration rate may increase gradually over time, until a maximum value is attained and, then, start decreasing again to either a value before wounding, or, to a higher value (Gorny 1997; Fonseca *et al*, 1999). Similar findings were reported by Lakakul *et al* (1999) where respiration rate in apple slices was found to be 2-3 times that in a whole-fruit. Increase in CO_2 evolution was lower in samples packaged in polypropylene bags of 50µm thickness, compared to samples packed in 25µm thick polypropylene bags. Lower the respiration rate, higher was the shelf-life of a sample. Shredded iceberg lettuce showed 35-40% increase in respiration rate compared to a quartered lettuce-head (O'Beirne, 1995). Respiration rate and other characteristics of any produce during storage change over a period of storage or any change in temperature (Dash *et al*, 2013).



*PP: Polypropylene bags

Fig. 1. Effect of packaging and storage conditions on respiration in minimally processed onion stored at 8±1°C and 83±2% RH

Table 2. Effect of packaging and storage conditions on biochemical quality of minimally processed onion at the end of storage (14 days)

Treatment	TSS (°Brix)			Acidity (%)		
	8±1°C	10±1°C	12±1°C	8±1°C	10±1°C	12±1°C
Initial	10.40	10.40	10.40	0.052	0.052	0.052
PP* bag 25µm	8.90	7.00	6.73	0.050	0.042	0.036
PP bag 50µm	9.50	8.33	7.67	0.042	0.044	0.043
PP bag 75µm	9.80	8.73	8.25	0.047	0.045	0.046
CD (1%)	0.04	NS	0.35	0.001	NS	NS

*PP: Polypropylene; NS: Non-significant

Table 3. Effect of packaging and storage conditions on biochemical quality of minimally processed onion at the end of storage (14 days)

Treatment	Pyruvic acid (µmol/g)			Reducing sugars (%)			Total sugars (%)		
	8±1°C	10±1°C	12±1°C	8±1°C	10±1°C	12±1°C	8±1°C	10±1°C	12±1°C
Initial	7.94	7.94	7.94	4.50	4.50	4.50	7.79	7.79	7.79
PP* bag 25µm	6.46	5.49	3.73	2.05	3.76	3.43	7.09	5.14	4.08
PP bag 50µm	7.61	6.48	4.87	2.18	3.92	3.59	7.20	5.45	4.23
PP bag 75µm	6.78	5.77	4.11	2.21	3.94	4.20	7.14	5.46	4.27
CD (1%)	0.13	0.12	0.71	0.07	NS	0.27	NS	0.10	NS

*PP: Polypropylene; NS: Non-significant

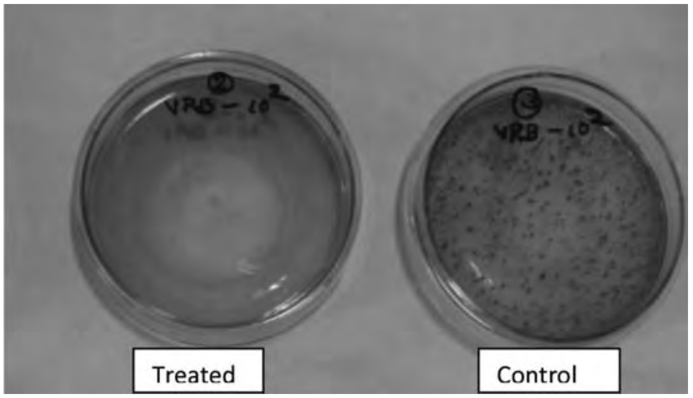


Fig. 2. Microbial quality of minimally processed onion at the end of storage at 8±1°C and 83±2% RH

f) Microbial quality in minimally processed onion

Microbial analysis showed that samples dipped in a solution of calcium lactate were microbially safe, as, the total Colony Forming Units in 10^2 dilution were found to be nil at the end of a storage period of 14 days at 8±1°C and 83±2% RH. These findings are similar to those of Finn and Upton (1997) who observed no pathogens in shredded carrot or cabbage packaged in polypropylene film (35µm thick) stored at 7°C.

It was found from our studies that onion cv. Arka Sona sliced with a plain, sharp knife and pre-treated with 2% calcium lactate; surface-dried and packaged in polypropylene bag sized 250X125mm (50µm thick) stored at 8±1°C and 83±2% RH, retained freshness and nutritive value, was microbially safe and acceptable, with a shelf-life of 14 days.

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