CIBTech Journal of Microbiology ISSN: 2319-3867 (Online)
An Online International Journal Available at http://www.cibtech.org/cjm.htm
2017 Vol.6 (3) July-September, pp.1-06/Yapa et al.
Research Article

EFFECT OF PRE-PROCESSING OPERATIONS ON MICROBIOLOGICAL QUALITY OF SELECTED DEHYDRATED VEGETABLES AND SPICES

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ABSTRACT
Fresh vegetables contain large amounts of water, usually above 90% and in the free form, thus, they are subject to microbial deterioration. At the same time, fresh vegetables occupy large volumes with tender tissues, posing difficulty in storage and transportation. By reducing their water content and subsequently their water activity and increasing their soluble solids contents, we can inhibit microbial activities, lower enzymatic activities, and increase the storage stability of vegetables. This process method is called dehydration. Dehydration of vegetables has a long history that shows various kinds of products that are nutritious, easy to store and transport, and convenient to consume (Cai *et al.,* 2004). Most vegetables enter drying plant carrying heavy microbial loads, mostly of soil origin. Treatments preparatory to drying will destroy a vast majority of these (Christian, 2000). In this study, several pretreatment methods were applied on several commonly used, selected commodities; leeks, carrots, onion and curry leaves. The basic pretreatment methods of blanching (hot water and steam) and washing (with chlorinated water 100pppm and 200ppm) were selected as the main types of pretreatments because of the minimum costs and less side effects. The effect of pretreatments/pretreatment combinations was identified on each commodity and the best pretreatment combination to minimize microbial counts for each commodity was also determined by using the values for microbiological parameters of total plate count, yeasts, moulds, coliforms and E-coli (positive or negative state) in the final dried product of each commodity and by comparing these values. The data were analyzed by using ANOVA with 5% significant level on MINITAB 15 software, according to the two factor factorial design (2 factors were washing and blanching). The results from the analysis were observed and compared. So, all the P-values were below 0.05, all the dried samples gave counts <10CFU/g for yeasts and only untreated (normal water washed unblanched) dried carrot samples gave E-Coli positive results. According to the means from ANOVA, the lowest means of Total Plate Count(TPC), Coliforms and Moulds for dried onion and curry leaves were given by 200ppm chlorinated water and hot water blanching pretreatments combination while lowest means of TPC, Coliforms and Moulds for dried carrots and leeks were given by 100ppm chlorinated water and hot water blanching pretreatment combination. There was a significant effect on microbiological quality measured in all those selected commodities of onion, carrots, leeks and curry leaves from the washing and blanching pretreatments individually and a there was a combined effect from the two pretreatments as well. The best pretreatment combination to get minimum microbial counts for dried onion and curry leaves was 200ppm chlorinated water, hot water blanching pretreatment combination. The best pretreatment combination to get minimum microbial counts for dried carrots and leeks was 100ppm chlorinated water, hot water blanching pretreatment combination. Blanching was necessary as a pretreatment to get coliforms counts lower than the IFST/FDA acceptable levels.

Keywords: *Blanching, Pretreatments, Chlorinated Water, Hot Water, Total Plate Count, Yeasts, Moulds, Coliforms and E-coli*

INTRODUCTION
Dehydration is a commonly used method to preserve so many food products like fruits, vegetables, eggs, milk, and fish because of their high perishability which is mainly due to the high moisture level. Dehydration can decrease the moisture level up to a certain extent by decreasing the water activity that

will result in the inhibiting the growth of microorganisms. The main purpose of dehydrating fruits and vegetables is increasing the shelf life or the preservation. Those dehydrated products are used in several other food industries as well like biscuits, soup mixes, noodle seasonings etc. Even though the moisture contents of such dried products are very low which is the crucial factor for microbial growth sometimes the microbial counts in dehydrated products are observed to be higher than the expected values, specially TPC, Yeasts, Moulds, Coliforms and sometimes even positive for E-Coli. So, the shelf life can be easily decreased due to the high microbial counts, by making the main purpose of dehydration, useless. So, the quality of the products they are being used can be largely decreased. There are many methods which can be used to decrease microbial counts such as gassing, irradiation, use of chemicals such as Sodium metabisulfite. But most methods are not well-applied because of side effects, high costs, and inconvenience to be applied in industrial level.

In this study, several treatment methods were used to identify the effect of best pretreatments/treatment combinations to minimize the microbial counts by comparing the microbiological parameters of total plate count, yeasts, moulds, coliforms and E-coli (positive or negative state) in each treatment method. The basic treatment methods of blanching and washing (with chlorinated water) were selected as the main types of pretreatments because of the minimum costs and less side effects with a main purpose of minimizing the microbial counts.

The main objective of this study was to determine the effect of different blanching methods and chlorine pretreatments (in washing water) on microbiological quality of dried carrots, leeks, onion and curry leaves. The specific objectives of this study were to determine the effect of selected chlorine contents in washing water on microbiological quality parameters in dried carrots, leeks, onion and curry leaves, to determine the effect of selected blanching pretreatments (steam and hot water) on microbiological quality parameters in dried carrots, leeks, onion and curry leaves and to determine the combined effect of two pretreatments on microbiological quality parameters in dried raw materials of carrots, leeks, onion and curry leaves and determine the best pretreatment/pretreatments combination for each commodity.

The acceptable levels of TPC, Coliforms count and Moulds count (according to IFST and FDA) for vegetables were within or below 10^5 CFU/g -10^6 CFU/g, 10CFU/g –10^3CFU/g and 10^3CFU/g -10^5CFU/g respectively (FDA, 2013), where onion was also considered as a vegetable according to FDA definition (Administration, 1980). The acceptable levels of TPC, Coliforms and moulds for spices (curry leaves in this study) were within or below10^4-10^6CFU/g, 10^2-10^3CFU and 10^2 -10^4 CFU respectively (FDA, 2013).

MATERIALS AND METHODS

Methodology

The big onion (*Allium cepa.L*), Curry leaves (*Murraya koenigii (L.)*) Carrots (*Daucas carota*) Leeks (*Allium porrum L*) were taken from the suppliers of CBL. Then, they were trimmed, peeled (only onion and carrots) and washed with normal tap water (Chlorine content 0.4ppm). After that they were washed with chlorinated water (100ppm or 200ppm) and sliced into pieces having 3mm thickness (For curry leaves the individual leaves were taken and the green leafy part was taken for leeks).

Then, they were blanched (hot water or steam). Then, the pretreated slices were cooled rapidly by using cold water with ice. Finally, these slices were dried in the Hot air dryer at 55^0C for about 22-24 hours. The final moisture content of the dried samples was maintained between 7-9%.

Pretreatment 1-Washing

The dehydrated products was prepared by washing with normal tap water, 100ppm and 200ppm Chlorinated water separately (about 1kg of commodity was washed with 1L Cl_2 solution) for about 2 minutes and only a part was dried and tested for microbiological parameters of TPC, Yeasts, Moulds, Coliforms and E-coli. Each microbiological parameter was duplicated.

Pretreatment 2-Blanching

After washing remaining part of each above treated slices were subjected to blanching treatment separately where they were blanched in boiling water or steam according to the Table 1 given below. Then, they were dried and tested for microbiological parameters of TPC, Yeasts, Moulds, Coliforms and

E-coli. Each microbiological parameter was duplicated. The pretreatments were carried out in two-factor factorial design and the pretreatment combinations were carried out according to the Figure 1 given below.

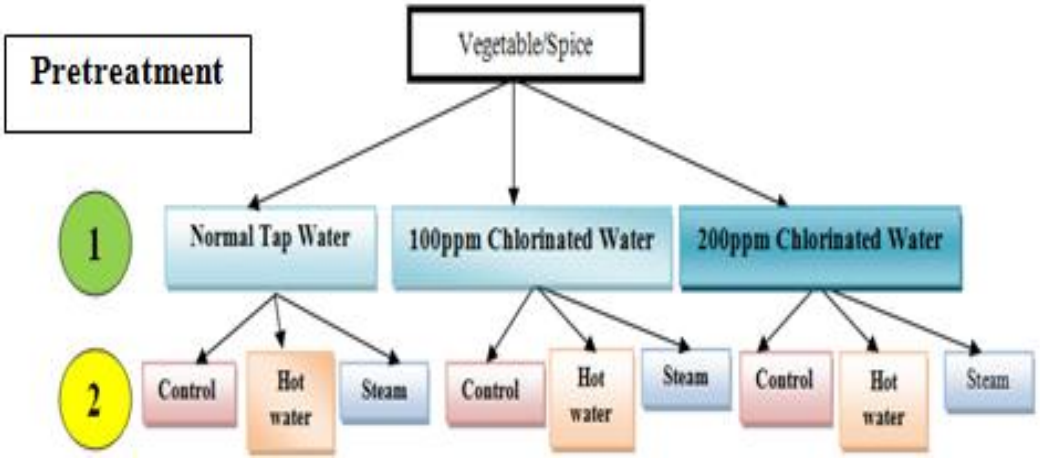

Figure 1: Pretreatment Combinations

Table 1: Blanching Times for Different Commodities Used

Commodity	Blanching Time	
	Hot Water	**Steam**
Onion	45 seconds	2 minutes
Carrots	1 minute	3 minutes
Leeks	1 minute	2 1/2 minutes
Curry Leaves	1 minute	2 1/2 minutes

RESULTS & DISCUSSION

The microbiological quality was assessed in this research as total plate count, coliforms, yeasts, moulds and E-coli (positive or negative state) for dehydrated products in each treatments combination to determine if there is an effect on these microbial parameters from the pretreatments/pretreatment combinations and data were analyzed by using ANOVA with 5% significant level (α=0.05) on MINITAB 15 software, according to the two factor factorial design where the two factors were washing and blanching. When considering the effect on microbiological parameters yeasts gave a count below <10 CFU/g which is acceptable according to the FDA and IFST standards which are below or within 10^2-10^4CFU/g for all samples on all commodities (FDA, 2013).

So, a significant effect was not observed on yeasts count in all the samples from each treatment from all commodities. Therefore, yeasts counts were not considered for the analysis. When considering about the E-coli only 2 sample types the control or normal water unblanched dried carrots were observed as E-coli positive.

From previous studies and tests the company has found that dried carrot samples tend to give E-coli positive samples in dried state when no pretreatments were given which was one of the major issues in dried vegetables. E-coli microorganisms may have easily entered into vegetables from soil with fecal contamination.

So, the treatments were carried out to overcome this, as well as to reduce the counts of the other microbiological parameters TPC, Coliforms, Moulds and yeasts. In other carrot samples zero E-coli

negative samples were observed which basically means that the treatments carried out have been effective. All the other samples were E-coli negative. It may be because optimum growth condition of moisture content for E-coli is above 25% (water activity: Minimum = 0.95, optimum 0.995) and the moisture content is lower than 25 % (7-9%) in all the pretreated and dried samples of each commodity (Chaplin, 2014) and (Microbiological Guidelines for Ready-to-Eat Foods., 1999).
The microbiological parameters taken onto the ANOVA analysis were TPC, Coliforms Count and Moulds Count.

Table 2: P Values from ANOVA

Commodity	Pretreatments	P-Value of each Microbiological Parameter		
		TPC	Coliforms	Moulds
Onion	Washing	0.000	0.000	0.002
	Blanching	0.000	0.000	0.000
	Interaction	0.000	0.000	0.000
Carrots	Washing	0.000	0.000	0.001
	Blanching	0.000	0.000	0.000
	Interaction	0.000	0.000	0.000
Leeks	Washing	0.000	0.000	0.006
	Blanching	0.000	0.000	0.000
	Interaction	0.000	0.000	0.019
Curry Leaves	Washing	0.000	0.000	0.000
	Blanching	0.000	0.000	0.000
	Interaction	0.000	0.000	0.000

According to the P-values from ANOVA as given in the Table 2, all were observed below 0.05 (5% significant level) interactions from 2 pretreatments have also given P-values below 0.05 which means there is a significant effect from these pretreatments individually as well as in combined level.
According to the means from ANOVA as in Table 3 the lowest means of TPC, Coliforms and moulds for dried onion and curry leaves were given by 200ppm chlorinated water and hot water blanching pretreatments combination while the lowest means of TPC, Coliforms and moulds for dried carrots and leeks were given by 100ppm chlorinated water and hot water blanching pretreatment combination. Those pretreatment combinations gave lower or within the acceptable range counts for Total Plate Count, Coliforms and moulds in many samples of the selected dried commodities in this study.
Onion is a bulb under the soil, carrot is a root under the soil, leeks are aerial parts, closer to the soil and curry leaves are aerial parts, not so close to the soil. Therefore, soil can act as a serious source of microbial contamination. Although, significant reductions were observed with chlorine & hot water blanching, there is a possibility that the remaining microbiological counts can still be a source of contamination.

Conclusion

According to ANOVA analysis with 5% significant level there was a significant effect on microbiological quality measured in terms of Total Plate Counts, Mould counts and Coliforms count in all those selected commodities of onion, carrots, leeks and curry leaves from the washing and blanching pretreatments individually and a combined effect from the two pretreatments was also there. The best pretreatment combination to get minimum microbial counts (within or below acceptable levels) for dried onion and curry leaves was 200ppm chlorinated water, hot water blanching pretreatment combination. The best pretreatment combination to get minimum microbial counts (within or below acceptable levels) for dried carrots and leeks was 100ppm chlorinated water, hot water blanching pretreatment combination. Blanching was necessary as a pretreatment to get coliforms counts lower than the IFST/FDA acceptable levels in these selected dried commodities.

Table 3: Mean Values from ANOVA

Commodity	Pretreatments	Mean Values TPC/CFU per 1g	Coliforms/CFU per 1g	Moulds/CFU per 1g
Onion	**Washing**			
	Normal Tap Water	1,616,667	12000.00	683.333
	100 ppm Cl_2 Water	1,065,000	10071.70	158.333
	200 ppm Cl_2 Water	795,000	6695.00	50
	Blanching			
	Control	2,566,667	26666.70	648.333
	Hot Water	200000	1006.70	10
	Steam	710000	1093.30	233.333
Carrots	**Washing**			
	Normal Tap Water	1,133,333	10716.7	35
	100 ppm Cl_2 Water	267,667	10516.7	10
	200 ppm Cl_2 Water	1093,333	11183.3	21.6667
	Blanching			
	Control	2206667	29666.7	46.6667
	Hot Water	114333	483.3	10
	Steam	173333	2266.7	10
Leeks	**Washing**			
	Normal Tap Water	105850	105850	46.6667
	100 ppm Cl_2 Water	12503	12503	26.6667
	200 ppm Cl_2 Water	113833	113833	53.3333
	Blanching			
	Control	208333	208333	78.3333
	Hot Water	8670	8670	10
	Steam	15183	15183	38.3333
Curry Leaves	**Washing**			
	Normal Tap Water	1012900	1656.67	1006.67
	100 ppm Cl_2 Water	258500	1040	1018.33
	200 ppm Cl_2 Water	108100	640	30
	Blanching			
	Control	1251667	3166.67	2023.33
	Hot Water	8167	75	13.33
	Steam	119667	95	18.33

ACKNOWLEDGEMENT
Authors wish to thank the academic and non-acadamic staff at the University of Sri Jayawardenepura, Sri Lanka and Staff at Ceylon Biscuits Limited Sri Lanka.

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