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INTRODUCTION OF FROZEN STORAGE TECHNOLOGY IN PAKISTAN: EFFECT OF FROZEN STORAGE ON THE QUALITY OF SPINACH

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In freezing, preservation is acheived by a combination of low temperature and reduced water activity. Spinach contains significant amounts of nutrients, however its general taste acceptability is usually consdiered to be more important than its nutritional value. Preparation for cooking is time consuming. In this study fresh spinach was prepared in ready-to-cook form and packed in polyethylene bags for frozen storage at -18°. An increase in reducing sugars and drip loss whereas substantial decrease in moisture, ascorbic acid and pH during frozen storage of spinach were noticed. The organoleptic evaluation showed that blanched spinach retained good colour, flavour and taste as compared with unblanched spinach during frozen storage.

Key words: Peroxidase, Blanching, Drip loss.

Introduction

Freezing is considered to be one of the best methods of fresh food preservation in the world. The immobilisation of water in form of ice in food results in low water activity which helps in preservation of foods.

Spinach (*Spinacea oleracea*) is an important vegetable. It is used in traditional oreintal dishes singly or in combination with meat, chicken, potato, radish etc. It is highly valued becuase of its taste as well as nutritional value (it contains vitamin A 5800 I.U., thiamine 0.12 mg/100 g, riboflavin 0.16 mg/100 g, niacin 0.8mg/100 g, ascorbic acid 52 mg/100 g, calcium 107 mg/100g, iron 2.1 mg/100 g, magnesium 103 mg/100g, phosphorus 66 mg/100g, potassium 710 mg/100 g and sodium 110 mg/100g [1].

Spinach leaves have to be washed four to five times after trimmming of the stem portion. Washing of the leaves is continued untill soil, sand and silt praticles have been completely removed. The preparation of spinach in ready-to-cook form is laborious and with modern life style where there is little time available for food preparation. The ready-to-cook frozen spinach can be served conveniently after cooking. To obtain a better quality product, the inactivation of peroxidase is emphasized [2]. Steam blanched spinach retains more nutritive value than water blanched spinach [3]. There are little changes in nutritional or sensory qualities in frozen foods when correct freezing and storage procedures are adopted [2]. Freeze preservation of spinach at time of abundant supply not only provides higher returns to the growers but also lower price product to the consumer.

At present, the freezing of spinach is not practiced in Pakistan. It was, therefore, planned to prepare frozen spinach in the laboratory and to evaluate its quality during frozen storage with an ultimate aim of exploring the scope of establishing a frozen vegetable processing industry in Pakistan.

Experimental

Product preparation and storage. The fresh spinach leaves, obtained from the University Vegetable Farm, were washed thoroughly with water to remove dirt and soil. The spinach leave were chopped into the ready-to-cook size (5 cm) after sorting of the blemished leaves. The spinach prepared in this way was divided into two portions. One portion was kept as such where as the other was blanched in hot water (80°), cooled immediately by immersion in iced water and drained. Both portions were packed in polyethylene bags (100 g per pack), sealed and stored for 90 days in deep freezer at -18°.

Product evaluation. The optimum blanching time for freshly prepared spinach was determined [4]. The frozen spinach was analysed [5] after suitable intervals during storage for drip loss, moisture, pH, reducing sugars and ascorbic acid contents. The ready-to-cook spinach was also evaluated organoleptically [6] before and after cooking for colour, flavour, taste by a panel consisting of 7 judges. Cooking was for 15 minutes. The results so obtained were subjected to analysis of variance techniques [7] to find the effect of blanching and frozen storage on the spinach quality.

Results and Discussions

Preparation loss. The preparation losses are given in Table 1. In this study they were found to be 9.7 ± 1.0 where as reported lossess varied between 40-50% [8]. These low losses might be due to the freshly harvested product directly obtained from the field.

Adequacy of blanching. The adequacy of blanching was determined qualitatively. It was found that peroxidase activity was high, very low, in trace and negative at blanching time of 0,30,60 and 90 sec. respectively (Table 2). On the basis of these observations it was found that the optimum blanching time in hot water at 80° for spinach was 90 sec.

Drip loss. Effect of blanching and frozen storage on the drip loss of spinach is given in Table 3. The drip loss was higher (33.0% and 33.4%) in blanched spinach as compared with unblanched spinach (31.0 and 35.1%). These results are supported by the findings of others [9] on frozen spinach. Increase in drip loss during frozen storage could be due to structural deterioration of the vegetable cells caused by fluctuation of temperature in environment because of unusual prolonged electric load shedding in this province.

Moisture. The results on moisture content of spinach before and after blanching and frozen storage are given in Table 3. The initial moisture was 95.1% and after 90 days it was 92.1%. Initially, the blanching treatment had no effect on the moisture content of the spinach where as after frozen storage it decreased both in the unblanched and blanched spinach in similar manner. The decreease in moisture content of the spinach was due to the formation of an ice layer of evaporated water [9] inside the packet.

pH. The results on pH as affected by the blanching treatment and frozen storage are presented in Table 3. The blanching treatment of the spinach caused a reduction in pH from 9.0 to 8.4. During frozen storage, a further slight decrease in the pH was observed both in unblanched and blanched spinach. Similar findings are reported elsewhere [10].

Reducing sugars. Effect of blanching and frozen storage on the reducing sugar content of spinach is given in Table 3. During blanching as well as during frozen storage the reducing sugar concenteration of the spinach remained unchanged, (i.e. 0.1 %) throughout. There was no change in sugars and starch contents of spinach during frozen storage as reported in earlier work [11].

Ascorbic acid. The ascorbic acid contents of unblanched and blanched frozen spinach as affected by storage are presented in Table 3. Blannching decreased the ascorbic acid concenteration (30.1 mg/100 g) compared with unblanched control (32.4 mg/100 g). The concenteration also decrease during frozen storage both in the unblanched spinach (from 32.4 mg/100 g to 23.4 mg/100 g) and blanched spinach (from 30.1 mg/100g to 23.6 mg/100 g). The rapid loss [12] and leaching of ascorbic acid [13] during hot water blanching and cooling has been observed. The loss of ascorbic acid of 50% during blanching and cooling has been reported [9]. A 7% loss in ascorbic acid during blanching and further losses of 27.8 - 21.6% after 90 days of frozen storage were found in this study.

Organoleptic evaluation. The organoleptic evaluation of frozen spinach for colour, flavour and taste as affected by blanching before and after cooking is given in Table 4. The smaples were evaluated by a panel of 7 judges after 0,30,60 and 90 days of frozen storage. These results showed that the colour, flavour and taste was superior in the blanched as compared with unblanched counterpart. The colour changes in leafy vegetables [14] during frozen storage due to the formation of dark colour compounds by polymerization of quinons from phenoles in the presence of oxygen has been reported (9). The overall flavour changes of frozen vegetable has been related to enzymic acitvity [15]. Frozen vegetables have better colour and flavour than canned vegetables [16].

The statistical analysis of the results obtained in this study demonstrate that blanching of spinach produces significantly better product in terms of colour, flavour and taste both before and after cooking.

TABLE 1. PREPARATION LOSSES IN SPINACH.

No. of obser-vation	Weight of sample (kg)	Weight after preparation (kg)	Weight loss (kg)	Preparation loss (%)	Mean
1	10.00	8.97	1.03	10.30	–
2	0.55	0.50	0.05	9.09	–
3	8.00	7.35	0.65	8.12	9.69
4	4.27	3.95	0.42	9.83	±1.02
5	3.15	2.80	0.35	11.11	–

TABLE 2. EFFECT OF TIME ON EFFECTIVENESS OF BLANCHING OF SPINACH.

Blanching time (sec.)	Peroxidase activity
0	****
30	**
60	*
90	–
120	–
150	–
180	–

**** = High, ** = Slight, * = Traces, - = Negative.

TABLE 3. EFFECT OF BLANCHING ON SOME OF COMPONENTS OF SPINACH AFTER FROZEN STORAGE.

Component	Treatments	Storage in days			
		0	30	60	90
Drip loss (%)	Unblanched	31.0	31.6	33.9	35.1
	Blanched	33.0	35.8	38.5	39.4
Moisture (%)	Unblanched	95.1	95.9	92.3	92.1
	Blanched	95.1	90.5	89.9	92.0
pH	Unblanched	9.0	8.4	8.3	8.4
	Blanched	8.4	8.3	8.2	8.2
Reducing sugar (%)	Unblanched	0.1	0.1	0.1	0.1
	Blanched	0.1	0.1	0.1	0.1
Ascorbic acid (mg/100 g)	Unblached	32.4	27.1	27.7	23.4
	Blanched	30.1	24.4	24.4	23.6

TABLE 4. EFFECT OF BLANCHING ON ORGANOLEPTIC CHARACTERISTICS OF SPINACH DURING FROZEN STORAGE.

Organo-leptic charac-teristics	Treat-ments	Scores out of 10 for standard of excellance storage in days								Means
		Unblanched				Blanched				
		0	30	60	90	0	30	60	90	
Colour	1	8.0	7.1	7.0	6.9	8.7	8.0	7.1	7.3	7.5
		±0.7	±0.9	±0.8	±0.8	±0.4	±1.0	±1.0	±1.3	
	2	8.1	8.1	8.0	6.1	8.9	7.6	7.3	7.4	7.7
		±0.7	±1.0	±0.9	±1.1	±1.2	±1.7	±1.0	±1.3	
Flavour	1	7.0	6.9	6.8	6.4	8.0	7.6	6.7	6.7	7.0
		±1.3	±1.0	±1.2	±0.9	±0.6	±0.9	±0.8	±0.9	
	2	7.7	6.7	6.7	6.7	8.0	7.6	7.4	6.9	7.2
		±1.0	±0.9	±0.9	±0.7	±0.7	±1.0	±1.3	±1.1	
Taste	1	8.0	7.6	6.9	5.9	9.0	7.4	6.4	6.3	7.2
		±0.7	±0.6	±0.6	±1.2	±0.4	±0.7	±0.7	±0.7	
	2	8.8	7.8	7.7	6.6	8.0	7.6	7.1	6.6	7.5
		±1.1	±1.5	±0.7	±1.2	±1.1	±1.7	±1.2	±1.2	
Means		7.9	7.4	7.2	6.4	8.4	7.6	7.0	6.9	

The results are expressed as means ±SD for 7 judges. 1 = Before cooking, 2 = After cooking

Stat. Significance	LSD		
Treatments	P=0.01	P=0.05	S.E. ±
Blanching	0.1620	0.2109	0.0759
Storage	0.2290	0.2980	0.1074
Cooking	0.1620	0.2109	0.0759

SD=Standard Deviation, LSD=Least Significance Difference, SE=Standard Error, P=Percent

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