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EFFECT OF DEHYDRATION AND PRESERVATIVES ON PHYSICOCHEMICAL PROPERTIES OF SUN-DRIED AND FREEZE-DRIED BUFFALO MEAT

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ABSTRACT

In this experiment meat slices were soaked in three different concentrations (5, 10, 15%) of sodium chloride (NaCl), each containing (l00ppm) sodium nitrite of (400ppm) ascorbic acid for 30 minutes at room temperature. Meat slices were then divided into two equal batches and subjected to sun-drying or freeze-drying process. Sun-dried meat samples were grounded into powder. Both meat samples were kept in plastic container for six months at room temperature. Untreated meat samples were used as control. Meat samples were taken during processing and storage for physicochemical analyses. (moisture content, crude protein, total lipids and NaCl). The obtained results showed that as the concentrations of NaCl in meat samples increased, the moisture percent removal increased too, followed by a gradual decrease during sun-drying, then increased slightly during storage period in both types of meat. Grinding process increased moisture content in meat samples. Salt treatment resulted in a noticeable drop in fat and protein content, the decrease was greater in sun-dried meat samples than that freeze-dried. Also fat, protein and salt percent decreased slightly as the storage period prolonged, the decrease was also higher in sun-dried meat.

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INTRODUCTION

Sun- drying is the oldest method and also the most frequently used drying method by many peasant farmers in recent time (Kuponiyi *et al.*, 1984). The drying of meat is a highly complex phenomenon which is influenced by the composition of meat, its water holding capacity, the processing of meat and micro organisms found in meat before and after the drying process. There is no doubt that drying of meat is an effective preservation process, but attention must be placed on the possible survival of micro organisms in the process in order to prevent spoilage and food born diseases (Gailani and Fung, 1986).

Intermediate meat products are produced by lowering the water activity 0.9 to 0.6. Such products are stable at ambient temperature and are produced in nearly every country in the world, specially in developing countries where refrigeration is limited. Traditionally intermediate meat products use low cost source of energy for drying, such as sun-drying and addition of salt. Such products are of interest since they do not require refrigeration during marketing and storage (Chang *et al.*, 1996). In

dehydration process, a food loses its moisture content which results in increasing the concentration of the nutrients in the remaining mass. Proteins, fats and carbohydrates are present in larger amounts per unit weight in dried foods than in their fresh counter part (Desrosier,1963)

Freeze-drying is a process based in the freezing and subsequent ice sublimation of the product, achieving a very high retention of both sensory and nutritional qualities (De Penna *et al.*, 1995). In freeze-drying, equipment and operation costs are higher and its drying capacity is smaller than those for sun and oven drying. For economic reasons, sun-drying is widely used, but strongly dependent on the weather and the length of the day and its more labour intensive than the other two methods (Chan *et al* ., 1997). In this process the total weight is often reduced by over 50 %, and the final moisture ranges from 1-4% and the product can be stored safely at room temperature (Desrosier, 1977). Overall, freeze-drying process appears to be the most appreciate drying method in retaining the nutritional composition of the dried foods (Sato and Hegarty, 1971 and Ratty and Das,1986).

Sodium nitrite is an important and widely used food additive, particularly in the preservation of meats, and it produces a characteristic flavour and pink colour in treated meats. Sodium nitrite may be useful as antioxidant against lipid oxidation during food processing (Osada *et al.*, 2000). Processors add sodium nitrite for colour fixation, antioxidant effect and inhibition of bacteria (Whiting and Masana, 1994). Ascorbic acid (Vit. C) is widely used as a preservative in food processing. Ascorbic acid is knows to act at both as an antioxidant, and as a pro-oxidant in meat systems under certain conditions (Sato and Hegarty 1971 and Ratty and Das, 1986). Dip treatment with a vitamine C solution was effective in maintaining stability of beef colour and lipid (Mitsuru *et a.*,1991).

The current research was designed to determine the effect of two methods of dehydration and preservatives on the physicochemical characteristics of buffalo meat during processing and storage.

MATERIALS AND METHODS

Hind quarters of buffalo meat containing semimembranosus, senitendionsus, performeris and intercostal musles were used in this study. They were obtained from three years buffalo male, from Faculty of Agriculture, Cairo university, Egypt. Fresh meat trimmings were differentiated into visually lean and fat portion and kept in the refrigerator at (5±°C) for 24 hours. The fresh muscles were cut approximately into 30 x 2 x 0.5 cm dimensions.

Preparation of Dipping Solutions:

Three different solutions of sodium chloride were prepared. Sodium chloride was weighed at three units of 50, 100 and 150g. Each unit weigh was dissolved in 1000ml (1 Litre) of water. The second solution was prepared as previously described, each containing 0.lg sodium nitrite/1. The third solution was prepared similarly to the second, each containing 0.4g ascorbic acid/1.

Dip Treatment and Drying:

Meat slices were soaked in three different solutions for 30 minutes, then divided into two equal batches. Samples of meat in the first batch were subjected to sun-drying for 4 days, then grounded into powder. Meat samples in the second batches were grounded and frozen at -30°C for 24 hours then, freeze-drying process was carried out using (Alpha 1-20) Christ Freeze-drier under vacuum at 0.05 mm Hg.

Packaging and Storage:

Both meat samples were packed in polyethylene bags and kept in plastic containers for six months at room temperature.

Sampling:

Meat samples were taken after 30 minutes of dipping then 2 and 4 days of sun-drying there after 0, 2, 4 and 6 months of storage at room temperature for the determination of moisture content, crude protein, total lipids and NaCl. Similar samples were taken for the chemical analysis of freeze-dried meat during storage.

Physicochemical Aanalysis:

Moisture content, total crude protein, total lipids and NaCl were determined according to the standard methods of A.O.A.C. (1975).

RESULTS AND DISCUSSION

Data illustrated in table show that moisture content of fresh meat was 75.28%, it reached 14.21 and 3.90 % after sun-drying for 4 days or freeze-drying process, respectively. As the concentration of sodium chloride increased, the rate of moisture removal increased too. Meat samples treated with high concentrations (10 and 15 %) of NaCl or and preservatives contained less moisture content compared to samples treated with 5% NaCl. Both meat samples showed slight increase in moisture content during storage at room temperature. Grinding sun-dried meat increased moisture content during storage, due in part to the increase of tissues surface exposed to moisture of air. However, moisture content was found to be lower than the save margin recommended for meat preserved by dehydration as reported by Zaitsov *et al.*,(1969).

The results in table (2) revealed that protein content reached 74.98% and 81.57% in sun-dried and freeze-dried meat samples respectively, compared to 18.70% in fresh meat. The more reduction of total protein in sun-dried than freeze-dried meat samples was probably due in part to the higher moisture in sun-dried meat and the effect of heat on the soluble fraction of protein. Protein content was not changed during storage period. Similar findings have been reported by Sherk (1975), who stated that total protein of sun-dried lamb meat showed no changes during storage at room temperature for 6 months. Salt treatment resulted in decreasing protein content compared to control.

Fat content in fresh buffalo meat muscles was 2.9%. Due to dehydration process it reached 9.97% and 10.46% in sun-dried and freeze-dried meat, respectively in table (3). Meat samples treated with NaCl before drying resulted in low lipids content compared to control.

Table 1 : Changes in Moisture Content (%) of Sun-dried and Freeze-dried Buffalo Meat during Processing and Storage for Six Months at Room Temperature.

Processing method	Sampling	Untreated Sample	Concentration of NaCl for samples dipped in								
			5%			10%			15%		
			NaCl	NaCl . $NaNO_2$	NaCl $NaNO_2$ Ascorbic acid	NaCl	NaCl $NaNO_2$	NaCl $NaNO_2$ Ascorbic acid	NaCl	NaCl $NaNO_2$	NaCl $NaNO_2$ Ascorbic acid
Sun-drying	During processing										
	Fresh sample	75.28	74.39	74.36	73.95	74.10	74.05	74.14	73.84	73.69	73.14
	Two days	27.83	26.73	27.55	25.04	22.28	23.30	23.85	21.18	22.20	21.85
	Four days	14.21	11.00	11.09	11.22	10.75	10.79	10.82	9.68	9.70	9.80
	During storage										
	Two months	14.72	11.30	11.45	11.55	10.90	10.95	10.98	9.70	9.75	9.92
	Four months	14.53	11.70	11.80	11.90	11.13	11.23	11.27	9.75	9.80	10.05
	Six months	14.82	12.25	12.32	12.41	11.22	11.33	11.39	9.99	9.89	10.14
Freeze-dried	During storage										
	Zero-time	3.09	3.87	3.77	3.72	3.60	3.55	3.49	3.20	3.00	3.00
	Two months	4.05	4.00	4.07	4.00	3.65	3.90	3.79	3.50	3.27	3.30
	Four months	4.30	4.20	4.30	4.36	3.65	3.98	3.89	3.56	3.57	3.50
	Six months	4.66	4.40	4.50	4.60	3.90	4.02	3.98	3.70	3.67	3.60

* $NaNo_2$ was added at 10ppm.

** Ascorbic acid was added at 400ppm.

Table 2 : Protein Content (%) of Sun-dried and Freeze-dried Buffalo Meat during Storage for Six Months at Room Temperature.

Processing method	Sampling	Untreated Sample	Concentration of NaCl for samples dipped in								
			5%			10%			15%		
			NaCl	NaCl . $NaNO_2$	NaCl $NaNO_2$ Ascorbic acid	NaCl	NaCl $NaNO_2$	NaCl $NaNO_2$ Ascorbic acid	NaCl	NaCl $NaNO_2$	NaCl $NaNO_2$ Ascorbic acid
Sun-drying	Zero-time	74.98	71.81	71.77	71.79	68.74	68.77	68.95	64.77	64.74	64.80
	Six months	74.50	71.68	71.60	71.59	68.58	68.50	68.97	64.48	64.54	64.44
Freeze-dried	Zero-time	81.57	79.29	79.22	79.70	73.74	73.90	73.97	70.32	70.41	70.44
	Six months	81.42	78.92	78.86	79.25	73.21	73.32	73.35	69.71	70.05	69.77

* $NaNo_2$ was added at 10ppm.

** Ascorbic acid was added at 400ppm.

Table 3 : Total Lipid Content (%) of Sun-dried and Freeze-dried Buffalo Meat during Storage for Six Months at Room Temperature.

Processing method	Sampling	Untreated Sample	Concentration of NaCl for samples dipped in								
			5%			10%			15%		
			NaCl	NaCl $NaNO_2$*	NaCl $NaNO_2$ Ascorbic acid**	NaCl	NaCl $NaNO_2$	NaCl $NaNO_2$ Ascorbic acid	NaCl	NaCl $NaNO_2$	NaCl $NaNO_2$ Ascorbic acid
Sun-drying	Zero-time	9.97	8.60	8.71	8.79	7.48	7.50	7.80	6.53	6.61	6.72
	Six months	9.59	8.40	8.52	8.65	7.27	7.34	7.40	6.40	6.46	6.55
Freeze-dried	Zero-time	10.46	9.84	9.88	9.89	8.72	8.85	8.93	7.66	7.73	7.89
	Six months	10.23	9.32	9.58	9.66	8.30	8.45	8.59	7.27	7.39	7.56

* $NaNo_2$ was added at 10ppm. ** Ascorbic acid was added at 400ppm.

Table 4 : Total Sodium Chloride (%) of Sun-dried and Freeze-dried Buffalo Meat during Storage for Six Months at Room Temperature.

Processing method	Sampling	Untreated Sample	Concentration of NaCl for samples dipped in								
			5%			10%			15%		
			NaCl	NaCl $NaNO_2$*	NaCl $NaNO_2$ Ascorbic acid**	NaCl	NaCl $NaNO_2$	NaCl $NaNO_2$ Ascorbic acid	NaCl	NaCl $NaNO_2$	NaCl $NaNO_2$ Ascorbic acid
Sun-drying	Zero-time	0.54	2.98	3.04	3.11	8.79	8.82	8.89	11.97	11.98	12.06
	Six months	0.53	2.92	2.96	3.03	8.72	8.73	8.77	12.01	12.02	12.03
Freeze-dried	Zero-time	0.61	3.21	3.25	3.29	9.05	9.06	9.04	12.26	12.50	12.84
	Six months	0.60	3.15	3.19	3.18	9.04	9.05	9.02	12.14	12.35	12.63

* $NaNo_2$ was added at 10ppm. ** Ascorbic acid was added at 400ppm.

The increase of NaCl in the brine (5 to 15%) reduced fat content. Similarly Kuo and Ockerman (1985) observed a decrease in fat content in freeze-dried meat with the increase of salt level (0.2 and 4%) at 25°C. The quantity of lipids in both meat samples was decreases slightly during storage period. Similar findings were reported by Mormatte *et al.*, (1986).

Results in table (4) showed an increase in sodium chloride pick up by meat tissues as salt in brine solution raised (5, 10 and 15%). Freeze-dried meat contained higher NaCl compared to sun-dried meat. Storage of sun-dried meat samples for six months a room temperature revealed slight reduction in NaCl content, this is probably due in part to the increase in moisture content in meat samples.

Conclusion

It could be concluded that the rate of moisture removal during sun and freeze-drying increased as the NaCl concentrations in dipping solutions increased. Both meat samples showed slight increase in moisture content during storage period. Freeze-drying process resulted in more reduction in moisture content than that of sun-dried. Slight reduction in NaCl content was also observed during storage of both meat samples. Treating meat samples with NaCl resulted in decreasing fat and protein content. No noticeable changes in protein and fat content was observed during storage of meat samples.

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تأثير عملية التجفيف والمواد الحافظة على الصفات الفيزيزكيميائية للحم الجاموس

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في هذه الدراسة تم نقع شرائح اللحم في ثلاثة محاليل مختلفة ٥ ، ١٠، ١٥% من ملح الطعام المحتوية على نتريت الصوديوم ١٠٠ جزء في المليون أو مع حامض الأسكوربيك ٤٠٠ جزء في المليون لمدة ٣٠ دقيقة على حرارة الغرفة ، ثم قسمت اللحوم المعاملة إلى قسمان لإجراء عمليتى التجفيف الشمسي أو التجفيد. تم فرم عينات اللحم المجففة شمسيا وحفظت كل العينات في علب بلاستيكية بعد تعبئتها في أكياس بولى أثلين لمدة ٦ أشهر على حرارة الغرفة وتم تحليل العينات للرطوبة ، البروتين ، الدهن ، وملح الطعام.

أظهرت النتائج أن المعاملة بملح الطعام أدت إلى انخفاض نسبة الدهن والبروتين في كل العينات مقارنة بالكنترول وكلما زاد تركيز الملح في العينات المعاملة كلما انخفضت نسبة الرطوبة وكان الانخفاض أكثر في العينات المعاملة بالتراكيز العالية (١٠ ، ١٥%).

لوحظ انخفاضا طفيفا في نسبة الدهن والبروتين لكل العينات وكذلك في نسبة الملح وزيادة في نسبة الرطوبة خلال التخزين.