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EFFECT OF SODIUM CHLORIDE SODIUM NITRITE AND ASCORBIC ACID ON THE MICROBIOLOGICAL QUALITY OF SUN-DRIED AND FREEZE-DRIED BUFFALO MEAT

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ABSTRACT

Meat slices were soaked in three different levels (5, 10 and 15%) of sodium chloride (NaCl), each containing (100 ppm) sodium nitrite or (400 ppm) ascorbic acid, for 30 minutes at room temperature (30ºC). Meat slices were divided into two equal batches and subjected to sun drying or freeze drying process. Sun dried meat samples were then grounded into powder. Both meat samples were packed in polyethylene bags and kept in plastic container for six months at room temperature. Untreated meat samples were used as control. Meat samples were taken during sun drying and storage for microbiological analysis (total count, coliforms, Staphylococci, Streptococci and moulds and yeasts). Freeze-dried meat samples were taken only during storage. Results show that soaking meat samples in NaCl or preservatives revealed a gradual decrease in total log No/g. Grinding process increased the number of micro organisms in sun dried meat. 5% NaCl or combined with preservative decreased slightly the bacterial Log No/g in both types of meat during processing and storage. Meat samples treated with (10 and 15%) NaCl or preservatives inhibited bacterial growth during storage. Combination of NaCl and preservatives showed a noticeable effect in decreasing bacterial log No/g compared to NaCl.

INTRODUCTION

Plant and animal foods, have been successfully preserved by the process of drying. In recent years, sun drying, spray drying, oven and cabinet drying have been practiced (Kuponiyi *et al*., 1984). Drying process reduced the water activity (aW) of the meat, which results in reduction in number of surviving micro organisms. Some spore forming organisms might survive these conditions and remained to contaminate the dried meat. Most of contaminants found in dried meat resulted from the contamination, because the procedure of handling the dried meat were no better than those used in handling the fresh meat (Faparusi, 1981).

Sun dried meat is called locally in some African countries Sharmoot. Sharmoot is traditionally prepared by cutting beef into strips, then sun dried for 3 to 5 days and grounded into powder. This procedure results in an extensive contamination by microorganisms and dirts (Gailani, 1988). The development of sound science-based methods to assure the production of high-quality and nutritious meat is needed. Such product also must be free of pathogenic microorganisms to assure their success in production and marketing (Chang *et al*., 1996).

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A variety of additives which have the potential for inhibiting the microorganisms have been investigated (Brew *et al*., 1995). Sodium chloride is commonly employed in conjunction with drying, and its useful in controlling microbial growth during sundrying and dehydration (Desrosier, 1963 and Whiting *et al*., 1984). Nitrite has been a valuable antibotulinal agent in cured meats and may offer some protection from the pathogens (Archer, 2002). Sodium nitrite is the source of nitric oxide, which is the real colour fixative, and has some bacteriostatic effect in acid solution. Ascorbic acid knows to act both as an antioxidant, and as a pro-oxidant in meat systems under certain conditions. At low levels (100 ppm) ascorbic acid catalyses the development of oxidative rancidity as indicated by increased Thiobarbituric acid (TBA) values (Sato and Hegarty, 1971 and Ratty and Das, 1986).

Freeze-drying, a process based in the subsequent ice sublimation of the product, achieving a very high retention of both sensory and nutritional qualities (de Penna *et al*., 1995). Freeze-drying is the method that is practiced for meat dehydration and according to the decrease in water activity (aW), this process is considered as one of the best method for meat dehydration. It is used for a number of foods, including meat poultry, sea food, fruits and vegetables (Frazier, 1984).

The objective of the current research was to determine the effect of sun- drying, freeze- drying and preservatives (sodium chloride, sodium nitrite and ascorbic acid) on the hygienic-sanitary conditions and microbiological quality of buffalo meat during processing and storage.

MATERIALS AND METHODS

Experimental Design:

The experiment was conducted using 2 x 3 x 7 factorial arrangement in a completely randomized design with three replication. The factors were 2 dehydration process (sun drying and freeze drying), 3 preservatives of sodium chloride, sodium nitrite and ascorbic acid and 7 sampling times (0, 2, 4 days of sun drying) than at (0, 2, 4, 6 months) of storage for sun-dried meat samples. However; freeze-dried meat samples were taken only during storage.

Hind quarters of buffalo meat containing semimembranosus, semitendionsus, performeris and intercostal musles were used in this study. They were obtained from three years buffalo male, from the Faculty of Agriculture, Cairo, Egypt. Fresh meat trimmings were differentiated into visually lean and fat portion and kept in the refrigerator at (5 $\pm$ 1^{o}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 150 g. Each unit weight was dissolved in 1000 ml (1 Litre) of water. The second solution was prepared as previously described, each containing 0.1 g/l sodium nitrite. The third solution was prepared similarly to the second, each containing 0.4 g 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 batch 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 (zero time) then after 2 and 4 days of sun drying thereafter 0, 2, 4 and 6 months of storage, for the microbiological analysis of sun dried and freeze dried buffalo meat.

Microbiological Analysis and Samples Preparation:

Twenty five grams of each treatment was aseptically removed and minced with sterile sand in a porcelain dish then transferred to 225 ml buffer peptone water in a 500 ml flask. Appropriate decimal dilutions f the sample were prepared in 0.1 percent sterile peptone water, 1 ml portion of each dilution pippetted into separate sterile Petri dishes. Some 15 ml of plate count agar, Baird Parker agar, Azide – Dextrose agar, Mac- Conkey agar and Sabraud agar were added to each plate for total aerobic plate count, Staphylococci count, Streptococci count, coliforms count and molds and yeasts counts, respectively. The plates were mixed gently and allowed to incubate for 24 hours at 37°C and 25 to 30°C for five days for molds and yeasts counts. Colonies wee counted using colony counter (Adesiyun *et al.,* 1983).

Statistical Analysis:

The microbial counts were presented as means expressed as log No/g.

RESULTS AND DISCUSSION

The total aerobic count in Table 1 revealed that the bacterial log No/g in fresh buffalo meat was 4.6. Soaking fresh meat samples in sodium chloride solutions decreased the log No/g to 3.6, 3/14 and 2.14 with raising NaCl concentrations 5, 10 and 15%, respectively. After four days of drying the long No/g reached 2.66, 1.34 and 0.00 for 5, 10 and 15% NaCl concentration, respectively. The decrease has been explained by (Desrosier, 1963 and Whiting *et al*., 1984). Also Talib *et al*. (2006) reported that as the NaCl concentrations in dipping solutions increased the rate of moisture removal during sun-drying increased too, and this is useful in controlling microbial growth. Grinding process increased slightly the microbial log No/g of sun dried meat. Mates (1983) attributed this to grinding process that distributes bacteria on the surface throughout the entire product, and creates an ideal condition for multiplication, also, he found that the bacterial log No/g decreased as the storage period progressed.

Combination of NaCl and preservatives showed a noticeable effect in decreasing bacterial log No/g compared to NaCl. Bacterial growth was not

observed during storage period in meat samples treated with 10 and 15% NaCl or preservatives, this was due to the incapacity of these pathogens to compete with high concentration of NaCl and preservatives. Similarly Salama and Khalafalla (1987) found that addition of sodium nitrite at 80, 120 ppm and ascorbic acid at 0.2% wee sufficient in reducing micro flora during meat processing. Similar findings wee reported by Romminger *et al*. (1982) when they used 10 and 100 ppm sodium nitrite in sausage.

The bacterial log No/g increased after 4 months of storage in meat samples treated with 5% NaCl or preservatives, this may be due in part to the increase in moisture content. Treating meat samples with 5, 10 and 15% NaCl and preservatives inhibited growth of Staphylococci, Streptococci, coliforms and moulds and yeasts during processing and storage, except in the control. However, Gailani (1988) reported that combination of water activity and sub inhibitory levels of antimicrobial agents were effective in inhibiting bacteria. The Log No/g of microbial total count in untreated meat samples declined gradually during four days of sundrying from 4.60 to 4.26, then increased gradually during six months of storage from 4.37 at zero time to 4.87. Adesiyun (1983) found that Staphylococci counts of dried beef stored at room temperature for 28 days declined from 9.9×10^5 to 3.0×10^3 CFU/g.

From the results in Table 2 freeze-dried meat samples treated with 5% sodium chloride or combination of preservatives decreased gradually during six months of storage from 2.43 to 0.77 and from 2.34 to 0.00, respectively. These microorganisms were completely inhibited after four months of storage in samples treated with 10% NaCl or combination of preservatives. Also, treating meat samples with 15% NaCl and preservatives inhibited all bacterial growth during processing and storage.

Staphylococci, Streptococci, coliforms and molds and yeasts were completely inhibited during processing and storage, except in the control. Previous report by Rawal *et al*. (1973) indicated that no pathogens or coliforms were detected in freeze dried mutton meat stored for two years. The elimination of these microorganisms could be attributed also to the variety of additives stated by Brew *et al*. (1995) and Archer (2002). Untreated meat samples demonstrated a gradual decrease in Log No/g during six months of storage from 2.44 to 2.07.

No difference was observed between both meat samples treated with sodium chloride and sodium nitrite and those treated with the combination of sodium chloride, sodium nitrite and ascorbic acid. However, incorboration of ascorbic acid did not show a noticeable effect in decreasing the number of bacteria.

CONCLUSION

Water activity is recommended as parameter for controlling the bacterial growth in meat products. Combination of sodium chloride and preservatives is useful in controlling microbial growth during sun drying and dehydration process. Salt over 5% controlled growth of micro organisms. Although studies in other countries indicated high prevalence of Staphylococci, Streptococci, coliforms and molds and yeasts in sun dried meats (Gailani, 1988 and Bennani *et al*., 1995) no isolates were obtained from any of the tested samples, in this study.

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تـأثير كلوريـد الصـوديوم ونتريـت الصـوديوم وحـامض الأسـكوربيك علـى المحتـوى الميكروبى للحم الجاموسى المجفف شمسيا أو المجفد

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أجريـت هـذه الدراسـة بهـدف معرفـة تـأثير عمليـة التجفيـف والمـواج الحافظـة علـى الحمـل الميكروبى للحم الجاموسى، وتم غمر شرائح اللحـم فى ثلاثة محاليل ٥، ١٠، ١٥% من ملح الطعام المحتـوى علـى نتريـت الصـوديوم ١٠٠ جـزء فـى المليـون، وحـامض الأسـكوربيك ٤٠٠ جـزء فـى المليون لمدة ثلاثون دقيقة على حرارة الغرفة، ثم قسمت العينات إلى قسمين لإجراء عمليتى التجفيف الشمسى أو التجفيد، وحفظت كل من هذه العينـات فـى علـب بلاسـتيكية بعـد تعبئتهـا فـى أكيـاس بـولى أثيلن على حرارة الغرفة لمدة ستة أشـهر أظهـر التحليـل الميكروبـى (العـدد الكلـى للبكتيريـا، البكتيريـا العنقودية الذهبية، البكتيريا السبحية، بكتيريـا القولون، والخمائر والفطريـات) أن غمـر شـرائح اللحـم فـى المحاليل المحليـة أدى إلـى تقليـل المحتـوى الميكروبـى وأن فـرم اللحـوم المجففـة شمسياً أدى إلـى زيـادة العـدد الكلـى للبكتريـا، وأن اسـتخدام تراكيـز ١٠، ١٥% أدى إلـى تثبيـط النمـو البكتيـرى خـلال فترة التخـزين، وأن اسـتعمال خليـط مـن ملـح الطعـام والمـواد الحافظـة كـان تـأثيره أكثـر مقارنـة بملـح الطعام لوحده.

Table 1: Log No/g of microbial total count of sun-dried meat during processing and storage for six months at room temperature.

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
During processing										
Zero-time	4.60	3.60	3.17	3.17	3.14	3.15	3.15	2.14	2.10	2.12
Two days	4.84	3.29	3.07	3.07	2.92	2.86	2.90	0.83	0.60	0.00
Four days	4.26	2.66	2.46	2.50	1.34	1.14	1.11	0.00	0.00	0.00
During storage										
Zero-time	4.37	2.77	2.53	2.59	1.41	1.26	1.29	0.00	0.00	0.00
Two months	4.47	2.62	2.32	2.38	0.00	0.00	0.00	0.00	0.00	0.00
Four months	4.60	1.53	1.23	1.25	0.00	0.00	0.00	0.00	0.00	0.00
Six months	4.87	1.70	1.53	1.45	0.00	0.00	0.00	0.00	0.00	0.00

*** $NaNO_2$ added at 100 ppm** **** Ascorbic acid added at 400 ppm.**

Table 2: Log No/g of microbial total count of freeze-dried meat during storage for six months at room temperature.

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
Zero-time	2.44	2.43	2.30	2.34	2.17	2.00	2.02	0.00	0.00	0.00
Two months	2.36	2.27	2.17	2.07	0.95	0.90	0.84	0.00	0.00	0.00
Four months	2.39	1.11	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Six months	2.07	0.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

*** $NaNO_2$ added at 100 ppm** **** Ascorbic acid added at 400 ppm**