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La Société Canadienne de Génie Agroalimentaire et de Bioingénierie
La société canadienne de génie agroalimentaire, de la bioingénierie et de l'environnement

Paper No. 06-191

PHYSICO-CHEMICAL CHARACTERISTICS OF BEEF JERKY

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Written for presentation at the
CSBE/SCGAB 2006 Annual Conference
Edmonton Alberta
July 16 - 19, 2006

Abstract. Jerky is one of the popular North American dried meat products and it presently relies on conventional drying methods for its processing. There is a need to improve the product processing conditions. Physical, chemical, and drying characteristics of beef jerky was explored for different salt content sample formulations. 1, 2 and 3 % salt content has been used as treatment levels. The samples were then dried in microwave and combination of microwave-convection drying units. Experiments were conducted to find the effect of salt content on drying characteristics of jerky. Physical and chemical characteristics of the dried samples were analyzed. It was found out from the study that salt content has a significant influence on drying characteristics such as drying rate and drying time and also it has a significant influence in physical characteristics like color, shrinkage, water activity etc.,.Increasing the salt content of the sample formulation has given better physical, chemical and drying characteristics in beef jerky.

Keywords. Microwave drying/heating, Jerky, meat drying, salt content, combination drying

1. INTRODUCTION

Jerky is one of the old traditional North American dried meat product and this self stable food product relies on salting and drying for its shelf life (Faith, N.G. et al. 1998). Low fat content, high calories and high protein are the special features of the dried meat jerky and it a favorite dish among hikers, hunters, bikers and skiers. Jerky can be added to enhance the flavor and nutrition of soups, stews and casseroles. As per USDA (1996) recommendation, this stable product should have a moisture- protein ratio of ≤ 0.75:1 and water activity of less than 0.85 to ensure the product safety.Martha Archuleta (2004) has analyzed different aspects of jerky processing and reported that there is no safe processing method available for Jerky. It is necessary to understand the processing behavior of beef jerky to improve the quality and market value.

As per Leistner(1995), the most important hurdles in food processing industries are temperature, water activity, acidity level,redox potential and preservatives(organic acids, spices). There are only limited details about relation between water content and water activity (Serra, X.et al.2005).

Calicioglu, M.et al. (2002) stated that texture is affected by drying jerky at high temperatures for extended periods of time. As per Mujumdar & Devahastin (2000), physical changes may include shrinkage, puffing, crystallization, glass transitions and in some desirable or undesirable chemical or biochemical changes may occur leading to changes in color,texture,odor and other properties. Selection of dryer depends on the type of the product to be dried, desired final product quality, the product's susceptibility to heat and the cost of drying (Cohen,J.S.& Yang,T.C.S.,1995).The protein content of dried meat is higher than fresh meat(Humphrey,k.J.T.,2002).Drying at very high temperature will result in improperly dried product due to the case hardening phenomenon of food material.

At present only the home dehydrators and smoke housing, which takes quite longer time, 10 hr with 60 °C (AAMP, 2004). So, there is a need of reducing the drying time. Presently, there is a no application of novel drying methods like electro magnetic radiation in Jerky Processing. Approximately 75% less energy is required for microwave heating as compared to conventional method (Quenzer& Burns, 1981). Microwaves fall between radio and infrared waves having wavelength of 0.025 to 0.75 microns and 20,000 to 915 MHz. In North America, Federal Communications Commission (FCC) has permitted only the following microwave frequencies 915, 2450 and 5800 MHz(Meda and Raghavan,2001). The domestic ovens operate at 2450MHz with a corresponding wavelength of 12.24 cm. Several studies have reported that microwaves could be used for surface pasteurization of meat. Meat treated with microwave less than 20s showed no drastic changes in appearance of physical characteristics

(Cunningham,1980).Microwave tempering or partial thawing of meat products has been already in practice(Taher,B.J. & Farid,M.M,2001). In the present study, the physical, chemical and drying characteristics have been studied for different formulation salt content. Gerrard (1935) has reported that the incorporation of the salts of strong acids such as sodium chloride helps in enhancing water holding capacity. The more strong ions are bound by the protein, the stronger will be the hydrating effect (Hamm, 1957). Manipulation of sample formulation for optimizing the product development was tried in this study.

Objective of the present study is to investigate the effect of salt content in physical, chemical, and drying characteristics of beef jerky in combined microwave-convection drying condition.

2. MATERIAL AND METHODS

2.1. Sample Preparation:

Biceps femoris muscles were taken for the study and it was stored at -30°C after the slaughter. The meat has been kept in 4°C environment for 48hrs before sample preparation. As per USDA (1996), recommendation, the meat was trimmed to lean to prevent fat being rancid while drying. The meat was first ground using a kidney plate in a meat grinder (Biro, Biro Mfd.Co, Marblehead, OH, USA).Before final grinding, the coarse ground meat has been mixed in a vacuum tumbler (H.Glass,Model-VSM-150,Frankfurt, Germany) for 2 minutes for improving uniformity. Then, the meat was ground twice, using a 1/8" blade in the meat grinder. The ingredients, given in the table 1, have been added with the ground meat to make 3 kg formulation in an Industrial Blender (Berkel BA-20, Model ARM-02) in lowest speed for 105 sec. 1, 2 and 3% salt was added to make three treatment levels.The mixture was then stuffed into slices of 6mm thickness in an industrial handfmann Stuffer (Albert Handfmann Mfd.Ltd., model-VF-80, West Germany). The slices were then vacuum packed and stored in -1°C freezer for further processing.

Table 1: Formulations for Different Treatments (All units are in grams)

Treatment	Meat	Salt	Sugar	Praque	Sodium Eythorbate	Water
1	2817.92	21.58	60	9	1.5	90
2	2787.92	51.58	60	9	1.5	90
3	2757.92	81.58	60	9	1.5	90

2.2. Drying:

Drying experiments were carried out in the laboratory scale microwave oven (Model-Panasonic NNC 980W) which has a provision to dry/heat in microwave, convection and combination of convective and microwave energy. Table 2 showed the specification of the microwave oven. This microwave oven has been modified to monitor online weight loss during drying and online temperature change. One end of fibre optic probe is connected to the Universal Multi channel Instrument, FISO Technologies Inc., Quebec, CA and another end will be in contact with the drying product. Data were acquired using the software Labview 6.0 (National Instruments, Austin, TX). Microwave-convective combination drying experiments were done with the air temperature was set to 70° C, air flow rate 1.45 m/s, microwave power of 295 Watts (pulse microwave 14 s ON and 7s OFF) and 33 % db final moisture content. The product temperature was monitored while drying using the online temperature-monitoring device. All the experiments were conducted with three replicates.

Table 2: Specifications of Panasonic NNC 980 W-Microwave Oven

Microwave Power Consumption	12.8 Amps, 1500 W
Heater Power Consumption	12.5 Amps, 1500 W
Microwave Output	1100 W
Heater Output	1400 W
Outside Dimensions	376 mm (H) x 606 mm (W) x 491 mm (D)
Oven Cavity Dimensions	242 mm (H) x 412 mm (W) x 426 mm (D)
Operating Frequency	2450 MHz

The dried samples were vacuum packed and kept in 4 ºC, as a prevention measure from moisture loss or gain.

2.3. Shrinkage loss Analysis

Initial and final volume has been measured and shrinkage coefficient was calculated by,

$$\text{Shrinkage Coefficient} = [1 - (V_f / V_i)] \times 100$$

Where V_f is the final volume and V_i is the initial volume of the sample (Trujillo, F.J et al. 2005).

2.4. Moisture content Measurement

Fresh and dried samples were passed through a precision grinder for three times with screen opening size equal to 3mm and the powder was mixed thoroughly after grinding. The 5 grams of

these ground samples were taken in covered aluminium dishes and placed in a vacuum at 100°C under 100 mmHg absolute pressures for about 5hours until it reaches a constant weight. Measurements were done in three replicates for each treatment. The loss in weight was measured as moisture content as per ASAE S353 (2003) method.

2.5. Water Activity Measurement

Water activity, which is the critical parameter used to assure the product safety was measured in Aqua lab water activity meter (Model CX2, Decagon Devices Inc., Washington, USA). The dried sample was crushed into small pieces and placed in water activity measurement cup and the readings were noted. Measurements were taken in three replicates.

2.6. pH Measurement

pH of the fresh samples were measured using the pH meter (Accumet-Model 15, Fisher Scientific). The pH meter was first calibrated with standard buffer solutions. 20 g of sample with 80ml of distilled water was mixed thoroughly in a household type blender for 30s. Electrode was immersed in the mixed slurry and the sample pH was read.

2.7. Color Measurement

Color of the meat before and after drying will be measured to indicate the appearance change. All the color measurements will be done using Hunter lab Color Analyzer- Labscan-2 (Hunter Associates laboratory,Inc. Virginia,USA). The fresh or dried samples were placed in the 1.25 cm of area of view and D65 was used as illuminant source. CIE lab color scale (L*, a* and b*) value were recorded, where 'L' coordinate indicates lightness, which represents the greyness ranging from black (L=0) to white (L=100). 'a' represents the redness/greenness of the product. Positive of 'a' indicates the redness of the product and the coordinate 'b' indicates the yellowness (positive) or bluishness (negative). Three replicates were taken for each treatment and six readings were taken. To evaluate the effect of different drying temperature on the overall combined color of dried meat, the index ΔE as given by following equation (Tabil.et al., 2001) was calculated by taking the color of fresh meat as the base value.

$$\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$$

Where $\Delta L = L - L_{base}$, $\Delta a = a - a_{base}$ and $\Delta b = b - b_{base}$, and L, a, and b are the color coordinates of the sample and L_{base}, a_{base}, and b_{base} are the color coordinates of the control sample.

2.7. Statistical Analysis

The experiment has been designed in Randomized Complete Block Design (RCBD) and all the data were analysed using factorial ANOVA test in SAS for windows V8 (SAS Institute, Cary, NC).

3. RESULTS AND DISCUSSIONS

3.1. Effect on Physical Characteristics

It was noticed from the observations that increasing salt content level of the formulation has given significant effect on water activity and shrinkage coefficient factor. Also, it was found that 3 % salt content has given lower shrinkage. There was no significant difference between 2 and 3 % salt content levels in weight loss. The results were shown in table 3.

Table:3 Physical Properties of Beef Jerky

Treatment	Salt content level	Initial Moisture Content (wb)	Water Activity	Shrinkage Co-efficient	Weight Loss
1	1 %	0.715	0.790a	51.31a	61.69a
2	2 %	0.684	0.785b	52.20a	57.90b
3	3 %	0.683	0.700c	31.69b	57.46b

In a column, same alphabets show no significant difference between treatment levels

Table 4 shows the CIElab color parameters L*,a* and b* values for different salt content level treatments. It was observed from the table that there was a significant difference among samples having different salt content levels. There was no significant difference between 1 and 3 % salt samples in grayness(L*) and redness(a*) values. There was no significant difference between 2 and 3 % salt content samples in yellowness(b*) value.

Table: 4 Color Parameters of Beef Jerky

Sl.No	Salt Content level	L*	a*	b*
1	1%	28.17a	19.80a	11.33a
2	2%	30.12b	20.67b	11.62a
3	3%	28.73a	19.18a	13.48b

In a column, same alphabets show no significant difference between treatment levels

3.2. Effect on Drying Characteristics

It was found from the study that there is a significant effect of salt content on drying characteristics of beef jerky. Lowering and increasing the salt content levels of the sample has caused a significant reduction in drying time. 3 %salt content samples have shown a lower drying time. Table 5 shows the drying data for samples having different salt content levels and Figure 1 shows the drying characteristics curves for different salt content levels.

Table: 5 Drying Characteristics of Beef Jerky

Sl.No	Salt Content level	Drying Time (Sec)
1	1%	447a
2	2%	454b
3	3%	420c

In a column, same alphabets show no significant difference between treatment levels

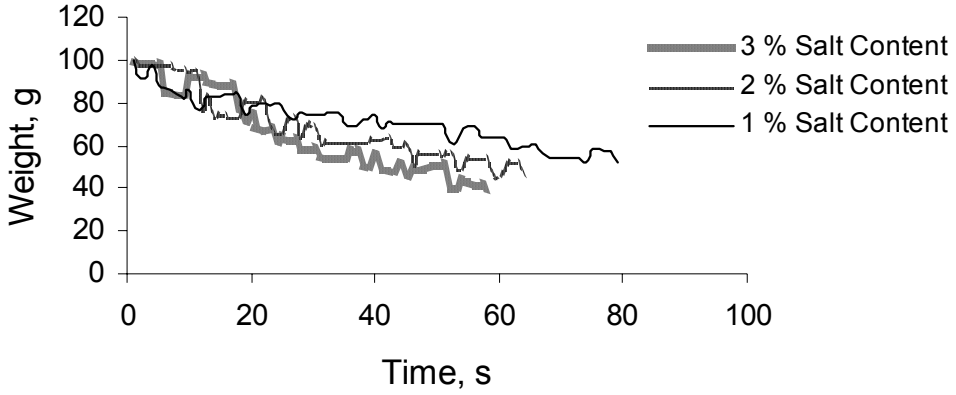

Figure 1. Drying Characteristics curve of different salt content samples

4. CONCLUSION

From the present study, it was found that the salt content has a significant effect on the drying and physical properties of beef Jerky. As, there is a increasing need for softer jerky among women and children, its necessary to study the different drying, textural and physical characteristics. Increasing the salt content level of sample formulation will cause a tremendous reduction in drying time, which in turn reduces the production rate. Compared to conventional jerky preparation method like smoke housing or home dehydrator, microwave and microwave-convectional combination drying helps in conservation in terms of time and energy. It is

recommended from this study that increasing salt content level provide lower shrinkage loss and gives more yield, thus giving better physical, chemical and drying characteristics for beef jerky.

ACKNOWLEDGEMENTS

I would like to thank NSERC for financial support and Mr. Wiebe for technical assistance.

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