Korean J. Food Sci. Ani. Resour.
Vol. 32, No. 3, pp. 263~267(2012)
DOI http://dx.do.org/10.5851/kosfa.2012.32.3.263

ARTICLE

Chemical, Textural and Sensorial Attributes of Biltong Produced through Different Manufacturing Processes

Semih Engez, Pelin Baskan, and Bülent Ergönül*
Food Engineering Department, Celal Bayar University, Manisa 45100, Turkey

Abstract

Six different types of biltong samples were manufactured from beef which was slowly frozen, quickly frozen or unfrozen. After marinating the samples according to the formulation used, meats were dried at two different temperatures (28±1°C or 42±1°C) until they lost half of their weights. Chemical, instrumental textural and sensorial analyses were done for determination of the most preferred sample and to compare the attributes of the samples with each other. It was found that, a_w values of the samples were among 0.81 and 0.83, whereas water contents were changing among the values 39.64% and 45.37%. There were no significant differences determined among the protein contents of the biltong samples ($p>0.05$). Fat, ash and salt contents of the samples were among the values 1.32% and 2.07%, 5.30% and 6.06%, 2.68% and 3.30% respectively. Hardness of the samples were found between 34.81 N and 44.13 N and there was no significant difference observed among the hardness values of the biltong samples ($p>0.05$). As results of the analyses, it can be concluded that the highest flavor, color, tenderness and overall acceptability scores were obtained for the sample QF-LT which was made from quickly frozen beef and was dried at low temperature (28±1°C) ($p<0.05$).

Key words: Biltong, sensorial analyses, textural attributes, intermediate moisture foods

Introduction

Removal of water by using drying techniques is one of the most important food preservation methods used world wide for years. By decreasing the water content of a food, growth and multiplication of microorganisms can be prevented. Today, instead of drying, "intermediate moisture food" concept is preferred in terms of manufacturing food products having an extended shelf life. Especially in African countries, intermediate moisture meat products having water activity values among 0.60 and 0.90 are widely produced and consumed. Most popular intermediate moisture meat product consumed in Africa is the biltong which is originated from South Africa (Attwell, 2003).

In general, intermediate moisture food products can be stored without chilling and can be easily produced, packaged and served (Nortje *et al.*, 2005). Especially in countries where the weather is generally hot and the refrigerated storage facilities are expensive, intermediate moisture food manufacturing is widely performed (Chang *et al*. 1996; Kalilou *et al*. 1998).

According to Chang *et al*. (1996) and Kalilou *et al.* (1998), Pastirma (Turkey, Egypt), Dendeng Giling (Indonesia), Came de Sol (South America), Khundi (West Africa), Charqui (Latin America), Bündnerfleisch (Switzerland), Quanta (East Africa) and Biltong (South Africa) are widely known and consumed intermediate moisture meat products. Mostly known one among these meat products is the "Biltong" of South Africa. Biltong is also marketed and consumed in several European countries. Unlike the other dried meat products biltong does not need to be rehydrated or cooked. It is a ready to eat meat product and seems to be a potential snack in several diets (Dzimba *et al*., 2007). Biltong also has found place in markets of Australia, Portugal, United Kingdom and USA (Attwell, 2003).

Especially meats from "silverside", "topside" or "eye of round" parts of beef are used for manufacturing biltong. Meat is sliced thin and dry-salted, then put into a mixture of apple vinegar, sugar, black pepper and coriander for curing. Because of the antimicrobial affects of salt, vinegar and nitrate, and the affect of drying process, biltong is known as a safe product in terms of food safety.

*Corresponding author: Bülent Ergönül, Food Engineering Department, Celal Bayar University, Manisa 45100, Turkey. Tel: 90-236-2412144 (2035), Fax: 90-236-2412143, E-mail: bulent.ergonul@cbu.edu.tr

Drying process of the biltong is approximately among 1-2 wk under sun.

Freezing and thawing is used as a combined process for manufacturing dried or intermediate moisture meat products. Freezing and thawing affect the quality and the composition of the meat product by affecting the water holding capacity of meat. Because of the macroscopic changes in meat tissue during freezing and thawing, amount of drip loss during drying, textural attributes and water holding capacity of meat products are affected. Amount of drip loss directly affects the drying period of the meat product, whereas the rate of freezing and thawing directly affect the drip loss amount of the meats. It is known that the drip loss amount of a fast frozen meat is more than of the drip loss amount of a slow frozen meat. From that point of view, in this research it was aimed to manufacture biltong by using different types of manufacturing methods and to determine the differences in chemical, textural and sensorial attributes of the samples. As it is seen in the materials and methods section, meat was frozen at different freezing rates (1.5 °C/h or 2.5 °C/h) and thawed in microwave oven and then dried at different drying temperatures (28°C or 42°C) and chemical, instrumental textural and sensorial analyses were done in order to determine the changes in quality attributes among the treatments.

Material and Methods

Meat was obtained from the part of the round of beef from an animal at an age of 18 mon. Following the slaughter, round of beef was kept at 4±1°C for 24 h and then stored at -1±1°C for 3 d.

The round of beef samples were cut into pieces in parallel to fibers having a thickness of 1.5 cm by using a slicing machine (General Machines, Cassano Magnago VA, Italia). Sliced meat samples were then separated into two groups. One group of the sliced round beef samples were frozen at -30±1°C at a freezing rate of 2.5 °C/h (quick freezing/RF), the second group meat samples were frozen at -11±1°C at a freezing rate of 1.5 °C/h (slow freezing/SF) until the thermal central temperature of the samples became -5°C. Temperatures of the samples were checked by using thermocouples (Hanna HI 98804, Povoa de Varzim, Portugal).

Frozen meat samples were thawed by using a microwave oven (Arçelik MD 594, Bolu, Turkey) at 360w (middle-low defrost mode). Thawed meats were then put in apple vinegar for 30 min. After that period, meat samples were cured by using a mixture of salt, brown sugar, black pepper and coriander for 3 h in a refrigerator at 4±1°C. Nitrite was not used. After 3 h, meats were soaked into mixture of warm water and apple vinegar (2:1) for the removal of salt present on the surface of the cured samples.

Cured samples were then put into drying chambers at two different temperatures, 28±1°C (low temperature/LT) or 42±1°C (high temperature/HT). Samples were kept at drying chambers until they lost 50% of their initial weights.

Also two control biltong samples were prepared without initial freezing process before curing. But similar to other samples, these two control samples were dried until they lost %50 of their initial weight in drying chambers at two different temperatures at 28±1°C or 42±1°C. Thus, 6 different groups of samples were obtained and coded as follows.

Unfrozen (UF) and dried at 28±1°C (LT), **(UF-LT)** (control 1); Unfrozen (UF) and dried at 42±1°C (HT), **(UF-HT)** (control 2); Quick frozen (QF) and dried at 28±1°C (LT), **(RF-LT)**; Quick frozen (QF) and dried at 42±1°C (HT), **(RF-HT)**; Slow frozen (SF) and dried at 28±1°C (LT), **(SF-LT)**; Slow frozen (SF) and dried at 42±1°C (HT), **(SF-HT)**.

After drying, biltong samples were sliced very thin into small pieces (3 cm in height, 1.5 cm in width and 1 mm thickness) by using the same slicing machine. Water activity values, fat, water, ash and salt contents of the samples were determined according to Vural and Öztan (1996) and AOAC (1990).

Hardness (N) values of the biltong samples were determined according to Harris and Shorthose (1988) by using a texture analyzer (TA-XT II, Stable Microsystems Ltd, Surrey, UK) equipped with a Warner Bratzler cutting knife. Load cell was 50 kg.

Sensorial analysis scores of the samples were determined by the method of Miller (1994). 8 panelists from the staff of food engineering department were asked to evaluate the samples in terms of juiciness, tenderness, connective tissue content, taste and color. Panelists gave their scores among 1 and 8 according to samples characteristics, where score 1 was representing excessively dry, excessively hard, excessively hard to chew, excessively poor and excessively red for juiciness, tenderness, chewiness, taste and color intensity respectively, where score 8 was representing excessively juicy, excessively tender, excessively easy to chew, excessively strong and excessively dark brown for the same characteristics.

All the analyses were repeated 4 times. Results of the analyses were evaluated by SAS programme (SAS, 2001). Method was completely randomized and PROC GLM procedure was used.

Results and Discussion

Average chemical composition of meat used in the study was given as Table 1. As seen from table, average water, protein, fat, ash and salt amounts of meat were 72.43%, 21.63%, 0.71%, 3.15% and 2.09% respectively. Average a_w value of the meat was 0.92 whereas pH value was determined as 5.64. According to Dzimba *et al.* (2007) average pH value of biltong is averagely 5.5.

Chemical compositions of biltong samples manufactured by using different methods were given as Table 2. Average a_w values of the samples were among 0.81 and 0.83, and it was determined that using different manufacturing methods did not significantly affected a_w values of the samples. Osterhoff and Leistner (1984) reported that average a_w value of biltong was 0.77. Average a_w values of our samples were a little bit higher than the findings of Osterhoff and Leistner (1984).

As seen from Table 2, average water contents of the samples UF-LT, UF-HT, RF-LT, RF-HT, SF-LT and SF-HT were 39.64%, 45.37%, 41.23%, 42.54%, 42.13% and 42.51%, respectively. Samples were kept in drying chamber until they lost the half of their initial weight. So, it was thought that the final water content of the samples was related to initial water content of the biological material. According to Nortje *et al*. (2005) average water content of beef biltong was 46.7%, whereas average a_w value was 0.92. Both average a_w value and water content of the samples are higher than our findings related to these characteristics. Differences in the value of a_w and water content may observed because of the differences coming from manufacturing technique and the chemical compositions of the beef samples used. As results of statistical analysis, it was observed that using different techniques in biltong manufacturing significantly affected the water contents of the samples (p<0.05).

Protein contents of biltong samples were among 44.21% and 49.69%, but there were no statistically significant difference was determined among the protein contents of the samples which were manufactured by using different methods (p>0.05). Same pattern was observed for the average fat contents of the samples. Fat contents of biltong samples were changing among the values 1.32% and 2.07%, but there were no statistically significant differences were observed among the fat contents of the samples (p>0.05). According to Nortje *et al.* (2005), fat content of beef biltong was 1.53%, which was similar to our findings related to fat content of biltong.

Average ash contents of the samples were changing among the values of 5.30% and 6.06%. Nortje *et al.* (2005) reported that average ash content of biltong samples was 5.65%. As results of statistical analysis results, it was found that there were no significant differences among the ash contents of the biltong samples manufactured by using different using different methods (p>0.05).

Average salt contents of biltong samples were among 2.68% and 3.30%. Highest salt content was determined for the sample SF-LT which was frozen slowly and dried at low temperature, whereas lowest salt content was determined for RF-HT which was frozen quickly and dried at high temperature. But, it was determined that there were no significant differences among the salt contents of

Table 1. Average chemical composition of beef round used for biltong manufacturing

Composition					
pH	a_w	Water (%)	Protein (%)	Fat (%)	Ash (%)
5.64±0.08	0.92±0.001	72.43±1.74	21.63±2.57	0.71±0.23	3.15±0.21

Table 2. Chemical attributes of biltong samples

Treatments[1)]	Composition					
	a_w	Water (%)	Protein (%)	Fat (%)	Ash (%)	Salt (%)
UF-LT	0.82	39.64±4.31^{b}	49.69±5.73	2.07±0.41	5.52±1.38	3.07±0.86
UF-HT	0.83	45.37±1.96^{a}	44.21±2.74	1.32±0.61	5.94±0.64	3.16±0.26
QF-LT	0.82	41.23±4.14^{ab}	48.53±5.12	2.01±0.54	5.30±0.74	2.93±0.74
QF-HT	0.82	42.54±2.12^{ab}	47.84±2.06	1.42±0.66	5.53±0.54	2.68±0.49
SF-LT	0.81	42.13±2.80^{ab}	46.56±4.13	1.95±0.44	6.06±1.13	3.30±0.70
SF-HT	0.83	42.51±3.85^{ab}	47.73±5.07	1.44±0.75	5.47±1.36	2.84±0.40

$^{a-b}$Means within a column having different letters are significantly different (p<0.05)

[1)]UF, unfrozen; QF, quick frozen; SF, slow frozen; LT, dried at 28±°C; HT, dried at 48±1°C

Table 3. Warner Bratzler hardness values of biltong samples

Items	Treatments[1)]					
	UF-LT	UF-HT	QF-LT	QF-HT	SF-LT	SF-HT
Hardness (N)	42.07±1.12	36.38±2.76	44.13±3.11	42.17±1.89	34.81±3.22	40.30±4.15

[1)]See Table 2

Table 4. Sensorial scores of biltong samples manufactured by using different processes

Items	Treatments[1)]					
	UF-LT	UF-HT	QF-LT	QF-HT	SF-LT	SF-HT
Juiciness	5.33[a]	4.21[b]	5.16[a]	4.45[b]	4.83[b]	4.66[b]
Tenderness	6.04[a]	4.71[b]	6.21[a]	6.00[a]	6.13[a]	5.13[b]
Flavor	6.04[a]	4.83[b]	6.21[a]	6.00[a]	6.13[a]	5.04[b]
Color	6.04[a]	4.71[b]	6.21[a]	6.00[a]	6.13[a]	5.13[b]
Chewiness	4.83	5.00	5.00	4.79	5.25	5.04
Hardness	6.04[a]	4.71[b]	6.21[a]	6.00[a]	6.13[a]	5.13[b]
Overall Acceptability	34.32[a]	28.17[b]	35.00[a]	33.24[a]	34.60[a]	30.13[b]

[a-b]Mean values within a column having different letters are significantly different ($p<0.05$).
SE_{color}, 0.36; $SE_{hardness}$, 0.24; $SE_{chewiness}$, 0.27; $SE_{juiciness}$, 0.25; $SE_{tenderness}$, 0.24; SE_{flavor}, 0.23.
[1)]See Table 2

the samples ($p>0.05$).

As seen from Table 3, hardness scores of the samples were among the values 34.81 N and 44.13 N, but there were no significant differences observed among the hardness scores of the samples.

Sensorial attributes of biltong samples were given as Table 4. As indicated in the table, juiciness scores of the samples were changing among 4.21 and 5.33, whereas the highest juiciness scores was achieved by the sample UF-LT. UF-LT was the sample which was not frozen before marinating and was dried at low temperature (28±1°C).

Tenderness scores of biltong samples were among 4.71 and 6.21. The lowest tenderness score was obtained for the sample UF-HT which was not frozen prior to manufacturing and was dried at 42±1°C, whereas the highest tenderness score was given for the sample QF-LT. Highest color score was also obtained by the sample QF-LT which was frozen quickly and dried at low (24±1°C) temperature. Chewiness scores of the samples were changing among the values 4.79 and 5.25 but there were no statistically significant difference were determined between the chewiness scores of the samples ($p>0.05$).

As seen from Table 4, flavor scores of the samples were changing among the values 4.83 and 6.21, whereas the highest flavor score was achieved by the sample QF-LT which was quickly frozen prior to manufacturing and was dried at 28±1°C. Also the highest overall acceptability score was obtained for the same sample but there were no significant differences observed among the overall acceptability scores of the samples UF-LT, QF-LT, QF-HT and SF-LT ($p>0.05$). Overall acceptability scores of the samples UF-HT (28.17) and SF-HT (30.13) were lower than the others ($p<0.05$)

Conclusion

According to results of the research, it can be concluded that, using different freezing and drying techniques during biltong manufacturing did not significantly affect the average a_w value and protein, ash, fat and salt contents of the samples ($p>0.05$), whereas average water contents of the samples were different from each other ($p<0.05$). On the other hand, hardness scores of the samples obtained from the texture analyzer showed no differences from each other. Manufacturing technique used did not affect the hardness values of the samples ($p>0.05$).

When sensorial analysis scores of the samples were taken into account, the most preferred sample was QF-LT which was made from quickly frozen meat and dried at low temperature. Highest flavor, color and tenderness scores were obtained for the same sample (QF-LT). There were no significant differences observed among the total sensorial scores of the samples UF-LT, QF-LT, QF-HT and SF-LT ($p>0.05$).

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(Received 2011.8.1/Revised 2011.12.4/Accepted 2012.6.8)