EFFECT OF ULTRASONIC-BRINING ON THE SALTING AND DRYING KINETICS IN BILTONG PROCESSING

M. Jones[1, 2], E. Arnaud[2, 3, 4], A. Collignan[5], P. Gouws[1], G. Atheaux[6]

and L. C. Hoffman[2]

[1]*Department of Food Science, University of Stellenbosch, Private Bag X1, Matieland (Stellenbosch) 7602, South Africa*

[2]*Department of Animal Sciences, University of Stellenbosch, Private Bag X1, Matieland (Stellenbosch) 7602, South Africa*

[3]*CIRAD, UMR QualiSud, F-34398, Montpellier, France*

[4]*CIRAD, UMR QualiSud, Matieland (Stellenbosch) 7602, South Africa*

[5]*MontpellierSupAgro, UMR QualiSud, Matieland (Stellenbosch) 7602, South Africa*

[6]*MOBIE, 97490 Ste Clotilde, France*

The study objective was to investigate the effect of ultrasound on the salting and drying kinetics during the processing of biltong. Biltong is a salted/dried South African meat product. Ultrasound was applied during the brining phase. Its impact on mass transfer during both brining of beef and its subsequent drying were studied. Contrary to what was expected, the ultrasonic-brining did not have a significant effect on either the salting or drying kinetics.

Key Words – meat, drying, salting, ultrasound

I. INTRODUCTION

Biltong is a salted/dried meat product traditionally produced in South Africa using moderate temperatures and low relative humidity. On a commercial scale, this traditional method is time consuming and can result in an unevenly dried product with high microbial counts [1].

Ultrasound is one of the emerging technologies that are currently being investigated as a method of food processing. It has been used in food research as a tool to both accelerate mass transfer and reduce microbial growth [2–5]. The ultrasound process as a novel technology for the food industry is less energy-intensive than other techniques and therefore more environmentally friendly and cost-efficient [5]. Many studies have been conducted on the use of ultrasound in the processing of fruits and vegetables by assisting air drying or as a pretreatment in liquid in order to reduce air drying time [6–7]. It has also been used in assisting the brining process of cured meat products to improve salt uptake [5, 8–11].

Ultrasound mechanisms are most pronounced at the solid to liquid interface, but also have effects within the meat matrix as ultrasound can affect liquid-uptake due to protein and myosin denaturation. Pressure fluctuations that occur due to soundwave cycles cause mechanical squeezing and releasing of the sample. In meat brining, this may lead during salting, to better impregnation of the brine within the meat. Ultrasound has also been shown to cause increased inter-myofibrillar spacing in post-rigor processed meat which could aid mass transfer [9, 11]. Therefore it would be of interest to assess the efficacy of the ultrasound to improve biltong processing as it could accelerate mass transfer during brining and the meat product matrix, thus affecting the drying time.

The aim of the study was to evaluate the effect of ultrasound on brining of beef meat in comparison with static brining. A secondary aim would be to determine whether ultrasound has an impact on drying thereafter.

II. MATERIALS AND METHODS

Raw meat material

Beef meat (*M. semitendinosus*) was cut parallel to the muscle fiber into 4 x 3 x 5 cm pieces. A combined total of 54 samples weighing 60.0 g (± 6.3) were used. The pH of raw meat muscle was on average 5.55 (± 0.06). Each meat piece was blotted to remove excess moisture and weighed before each treatment.

Impact of US-brining on salting kinetics

All equipment, such as the brining containers, solutions and ultrasound apparatus was kept at 5ºC. The salt kinetics trial investigated six treatment groups for each brining technique (static- and ultrasound-brining), namely 10 min, 20 min, 30 min, 40 min, 60 min and 90 min. Each treatment group consisted of three replicates for each technique. For the brining treatments, meat pieces were placed in individual 2.5L plastic containers using a plastic grid support for the meat piece and left for the allotted time period. For US treatments, a high intensity ultrasonic processor (VCX 750; Sonics & Materials. Inc., Newtown, CT, U.S.A) was used at a set frequency of 20 kHz with an electrical power of 750W. All treatments were applied at 5ºC, using an ice-waterbath to keep the temperature constant. Temperature was monitored using a thermometer. A 200 g/L water salt solution was used as the brining solution at a 1:15 solution/meat mass ratio accordingly. After each brining treatment, the sample was rinsed in water and blotted dry with absorbent paper before being weighed again.

Impact of US-brining on drying kinetics

Brining was conducted at 10°C with the same salt solution and ratio during 60 min with or without ultrasound using the same procedures as with the previous trial except for the ultrasound apparatus (REUS, Contes, France). The ultrasonic frequency was at a set 24 kHz with an electrical power of 200W. Each treatment group consisted of three replicates for drying and one meat piece which was used for the determination of moisture content and pH after brining (before drying). Salt content was determined after drying and was used to calculate salt content after brining. All treatments were conducted on the same day.

The drying occurred 12 hours after completion of the brining treatments to allow for the salt to settle. All meat pieces were placed in an environmentally-controlled drying chamber at parameters of 30% relative humidity at 30ºC until a 50% weight loss was reached. The pieces were each weighed before and during drying every hour.

Analytical methods

After brining or drying, meat pieces were minced and samples were taken for analysis. Moisture content was determined according to the AOAC Method 934.01 (2002). Salt content was determined according to the method adapted by Varlik *et al.* (2007) or with a Model 926 chloride analyser (Sherwood Scientific, Cambridge, UK).

Data analyses

The following calculations were used to determine the weight loss (WL), salt gain (SG) and water loss (WaL) during brining on a g per 100 g initial meat mass.

$$WL = \frac{m_{initial} - m_{final}}{m_{initial}} \times 100$$

$$SG = \left(SC_{final}\frac{m_{final}}{m_{initial}}\right) - SC_{initial}$$

$$WaL = MC_{fresh\ meat} - MC_{final}\frac{m_{final}}{m_{initial}}$$

The *m* indicates the mass of the sample (g), *SC* is the salt content (g/100 g wb) and the *MC* is the moisture content (g/100 g wb). Initial describes values before brining, and final describes values after brining.

The drying process was monitored every hour calculating the moisture content (MC) which is expressed as g per g (dry basis).

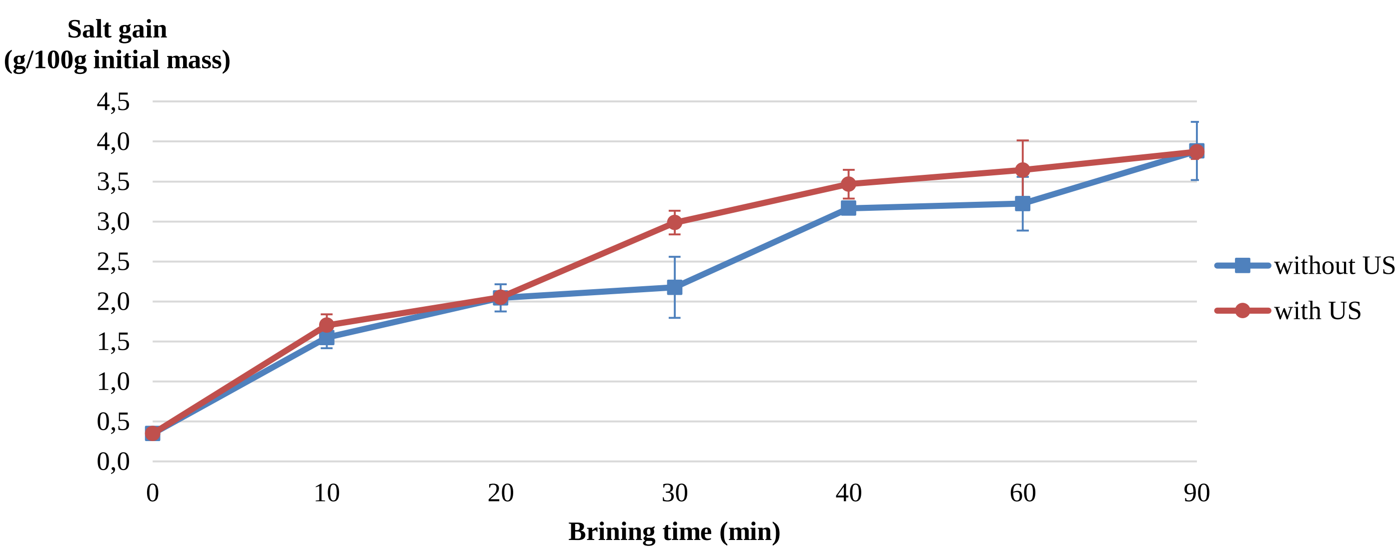

Figure 1 Salt gain over brining time (n=3). Error bars represent the standard deviation.

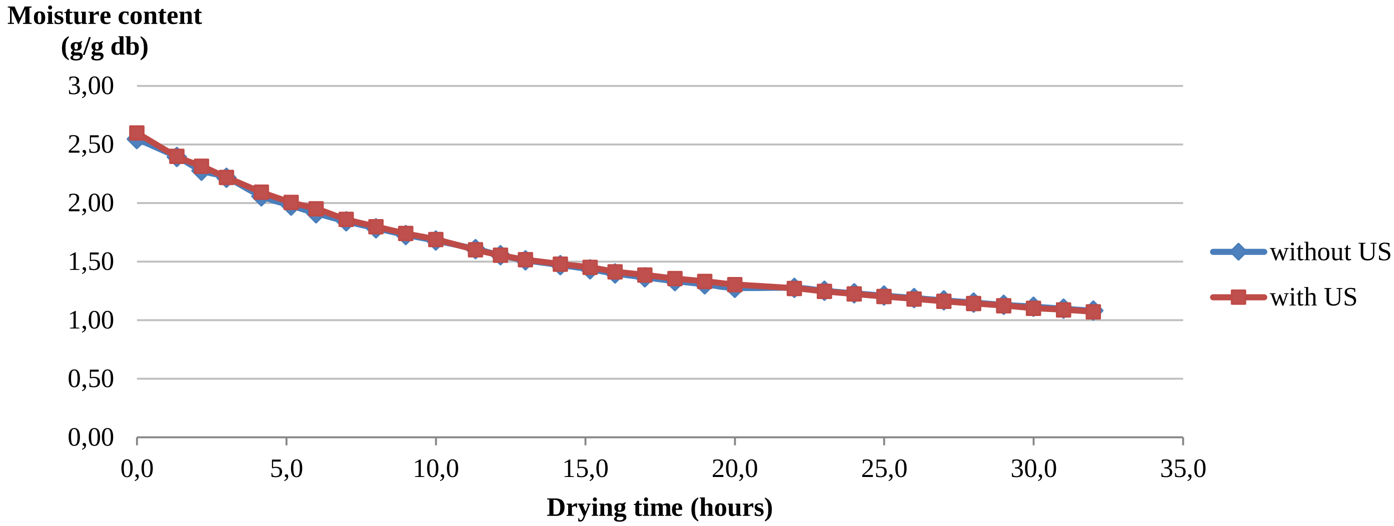

Figure 2 Moisture content (dry basis) over drying time (n= 3)

III. RESULTS AND DISCUSSION

Impact of US-brining on salting kinetics

Salting kinetics during brining is depicted in Figure 1.

There is only a significant effect of US on salt gain at time 30 min and 40 min which have a higher salt gain than the static-brining treatment but this is not confirmed by water loss and weight loss. In fact, no significant differences between static and ultrasonic-brining were seen in the weight loss and water loss results (not shown), they do however correspond with the salt gain results.

Both static- and ultrasonic-brining treatments reach the highest salt gain at 90 min (3.9 g/100 g initial mass). These results suggest that, with these parameters, a 60 to 90 min treatment would be sufficient for biltong as the salt gain before drying, close to 3.5-4%, will allow for an approximate salt content after a 50% weight loss drying closer to the salt content of biltong (5 - 8%).

A 60 min treatment was used when investigating the impact of US treatment on drying.

Impact of US-brining on drying kinetics

The salt content before drying for each treatment confirmed there was no impact of US on salting during brining (3.4 ± 0.24 g/100 g wb with ultrasonic-brining and 3.1 ± 0.28 g/100 g wb without US). They are slightly lower than with the previous trial probably due to difference of raw material.

Drying kinetics showed that the brining process of the meat before drying does not influence the moisture content consistency with a moisture content (wet basis) decreasing from an initial ± 72.0 g/100 g wb to ± 47.8 g/100 g wb for both treatments. Therefore, the ultrasound treatment of the meat before drying does not influence the drying time as there were no differences between the samples (Figure 2). Both static brining and ultrasound treated samples took 32 hours to reach a 50% final moisture content.

CONCLUSION

Ultrasound has a very small impact on mass transfers during brining in our conditions contrary what was showed in other studies. It was shown that ultrasonic-brining did not influence drying. However it could be interesting to study its impact on homogeneity of salt distribution. Furthermore it could influence the microbial load of meat and thus shelf-life (microbial stability).The penetration of spices added in the ultrasound bath could also be improved which could influence the flavour and microbial stability of the final dried product. Further experiments should be undertaken in this field.

ACKNOWLEDGEMENTS

This is an outcome of a collaboration between the QualiSud research unit and Stellenbosch University which has been initiated in meat processing.
The authors thank gratefully the Regional Council of La Reunion (French overseas territory), the European Regional development Funds (ERDF) and the French Government for their financial and technical assistance through the QualiREG research network in Indian Ocean (www.qualireg.org). This work is based on the research supported by the South African Research Chairs Initiative of the Department of Science and Technology and National Research Foundation of South Africa. Any opinion, finding and conclusion or recommendation expressed in this material is that of the author(s) and the NRF does not accept any liability in this regard.

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