EFFECT OF STORAGE ON THE TECHNOLOGICAL CHARACTERISTICS OF MEAT STICK MADE OF INSECT AND PORK

ALTERNATIVE BURGER MEAT

Richard PINTER[1] – Evelin MOLNAR[1] – Khabat N. HUSSEIN[1] – Adrienn TOTH[1] – Laszlo FRIEDRICH[1]– Klara PASZTOR –HUSZAR[1]

[1]: Szent István University, Faculty of Food Science, Department of Refrigeration and Livestock Products' Technology, H-1118 Budapest, Ménesi út 43–45

Abstract

The objective of this study was to research the adaptability of insects in food products. Hamburger patties were made with pork meat and insect batter (in a 50:50 ratio) and we studied the colour, water-holding capacity, cooking loss, texture and microbiological traits during ten days of refrigerated storage (5 °C, vaccum packaging, air cooling). Similar products are already available in European markets, but these are made of 100% of insect meat or with additional vegetables as an ingredient. This study concluded that the addition of insect could reduces cooking loss and reduces the rate of microbial growth, while the added insect create a softer texture. This is the reason why it could be interesting to inspect the different quality parameters of burger patties with pork meat and insect meat.

Keywords: hamburger patties, entomophagy, insect eating, storage

1. Introduction

By 2050 the Earth population will be higher than 9 billion. As a result of this, food consumption will vastly increase (Godfray et al., 2010). With this the need for animal derived proteins and the want for higher quality food will also escalate. The yearly meat consumption will rise from 200 billion tons to 470 billion tons, the grain consumption will augment from 2,1 billion tons to 3 billion tons. Furthermore, the World's agricultural land use will be higher due to food production purpuses (nowadays it is 45 %) (Thornton et al., 2011). The development of modern technologies is pointless as the growth of the problem is getting unstoppable. Therefore, we need a solution wherewith the agricultural footprint and the industrial waste will be at minimum level though the food production will keep up with the demand of growing population (Lundqvist et al., 2008). In consequence, we have to change our eating habits. The entomophagy (insect eating) and the developing insect industry could be a solution for the problems or at least it may reduce them. The utilization of insect based product has many advantages. It is more environmental friendly (lower water use (Vogel, 2010)., less land use (Zanolli, 2014), lower emission of green house gases (Fiala, 2008)) and waste reducing because they can be fed on organic byproducts (Dossey et al., 2016). Moreover these products are extremely healthy as they have high vitamin and protein content (Bukkens, 1997), have increased amount of essential amino-acids and have some minerals and unsaturated fatty acids in high quantity (Finke et al., 1987).

On the other hand nearly all Europe and the majority of the world do not support these ingredients because of religious, social, emotional and other reasons (Looy et al., 2013) although it has been present since the ancient times (Lesnik, 2011). The researchers should elevate the level of acceptability and should spread more information about the advantages of entomophagy. Most of the studies investigate the edible insects from the view of climate change or the sensory aspect. Considering this, in this research we concentrate on the technological benefits (or downsides) of using insects in food. Alternative insect based meat products (e.g. Essento, Bugfundation) have already existed in European markets like Switzerland or Germany, but these are made of 100 % of insect meat or with additional vegetables as an ingredient. This is the reason why it could be interesting to investigate the different parameters of burger patties with pork meat and insect batter.

2. Materials and methods

2.1. Materials

The ingredients consisted of superworms *(Zophobas morio)* from the Bugs World company in Budapest, Hungary; minced pork meat (with 25,5% fat content) and yellow onion from SPAR Hungary Commercial Ltd.; garlic powder, ground roman cummin and ground black pepper from Szilasfood Ltd., table salt mixed with nitrite (99,5% $NaCl$+0,5% $NaNO_2$), soluprat (tetrasodium-pyrophosphate) and Na-ascorbate from Solvent Commercial House Ltd.

2.2. Methods

2.2.1. Samples preparation

The processing of the fasted and hibernated superworms began with cleaning and steaming (96 ˚C, 200 g, 4 min) then they were ground with a Moulinex HV6 type meat-grinder (3000 1/min). In the early stages of product development it became clear that chitin pieces can be quite hard to chew and may negatively affect consumer acceptance. Because of this, chitin particles were removed by passing through a sieve from a part of the samples. (with 0,4 mm diametrical mesh). This research investigated the following samples: P= patties made of 100 % **p**ork meat (control sample), C= patties with insect meat with **c**ithin, RC= patties with insect meat with **r**educed **c**ithin content. The recipe of samples P is the following: 440 g minced pork meat, 0,42% Na-ascorbate, 0,34% soluprat, 1,67% salt mixed with nitrite, 0,39% ground black pepper, 0,27% ground roman cummin, 5,68% roasted yellow onion, 0,82% garlic powder. In the case of RC and C patties half of the pork meat was substituted with the particular type of insect batter and then mixed. The batters with different meat combinations were vacuum packaged. Samples were stored at 5°C. Little sticks (~20 g/ stick; r=7mm, h=70mm) were formed from the packaged meat batters on the measurement days, after that the sticks were cooked at 185 °C for 10 minutes (turning them once) in a souis vid oven. The tests were performed on 0th, 3rd, 5th, 7th and 10th day.

2.2.2. Water-holding capacity

The water-holding capacity (WHC) was examined according to Grau és Hamm (1953) and results were calculated using AutoCAD 2017 program from five parallel measurements.

2.2.3. Cooking loss

The sample sticks were measured before and after cooking. Cooking loss was calculated with the following formula: cooking loss (%) = $((m_{original} - m_{cooked}) / m_{original}) *100$

2.2.5. Colour analysis

The colour characteristics of samples were measured using a Konica Minolta CR 410 type digital colorimeter. The a*, b* L* values were analyzed with the avarage of five parallel measurements before and after cooking inside and on the surface of the sticks.

2.2.6. Texture

Stable Micro System TA.XTplus type device was used to monitor the changes in texture during storage after cooking. Warner-Bratzler head was used (fix counterweight: 50 g, velocity: 2 mm/s). Data were evaluated with Texture Exponent 32 software to determine the maximum penetration force (N) using the avarage of nine parallel measurements.

2.2.7. Microbiological analysis

The aerob mesophilic microbe count (CFU/g) were analysed according to the MSZ 3640/4-86 Hungarian standard using TGE agar, with 48 hours incubation period at 30 °C.

3. Results and discussion

3.1. Water-holding capacity (WHC)

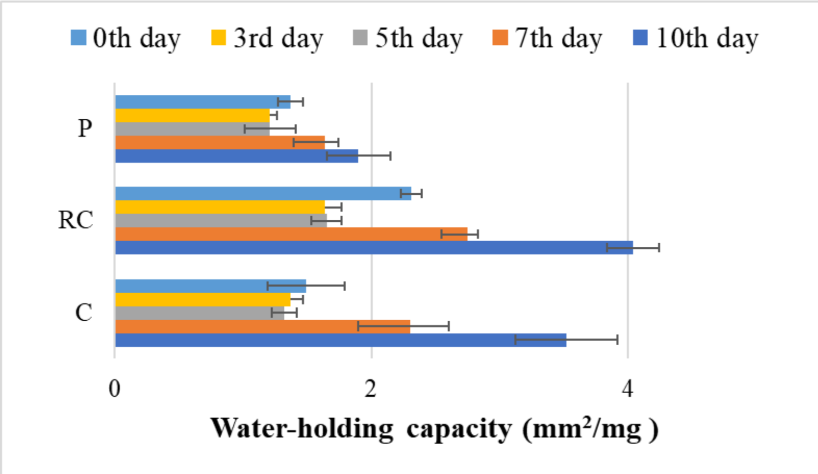

***Figure 1.**: Changing of WHC during storage (P= pork, RC= reduced chitin, C=with chitin*)

On the 0th day (Figure 1.), all of the samples had almost the same value. This indicated the evolved protein stucture's strenght and that they did not lose a huge amount of moisture due to mechanical effect. However, the WHC of samples made with insects (RC, C) decreased on the 7th day, which marked the disintegration of the protein structure. The bonds developed during steaming broke up and more water was released.Furthermore, homogeneity also influenced the end results because the C sticks did not loose as much moisture as RC.

3.2. Cooking loss

The RC and C samples released almost 10 % less moisture than the P sticks. (Figure 2.).

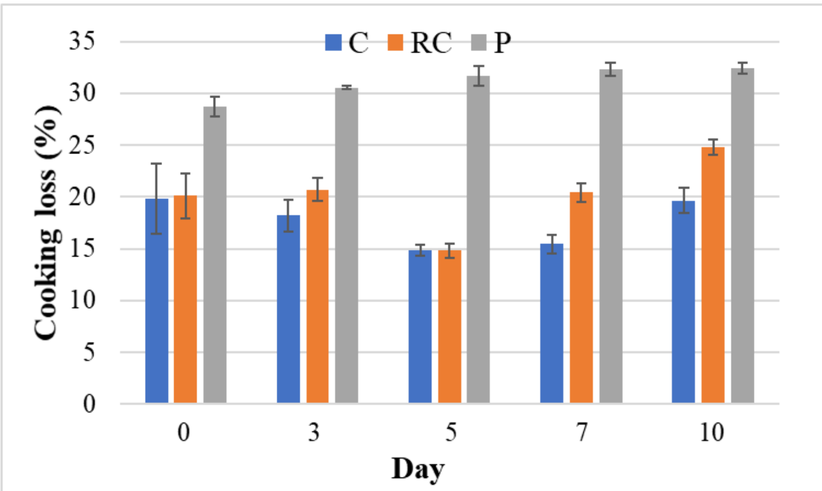

Figure 2.: *Cooking loss during storage (P= pork, RC= reduced cithin, C=with chitin)*

The RC and C products contained 31,6 % protein (calculation based on the USDA National Nutrient Database) on the other hand the P sticks had 16,4 % protein (calculated from the minced meat nutritional chart). In consequence, the RC and C samples created a more stable protein system which could hold moisture in the batter more effectively.

3.4. Colour

Lightness (L*) increased in case of every sample (Figure 3.) so the samples became lighter during the progress of time. However this difference was not that outstanding which proved the effectiveness of vacuum packaging. In opposition, the cooked sticks were lighter by ten units. The colour of the surface was darker as heat penetrated less into the inner part of the product. This variations also appeared in the values of a* and b*.

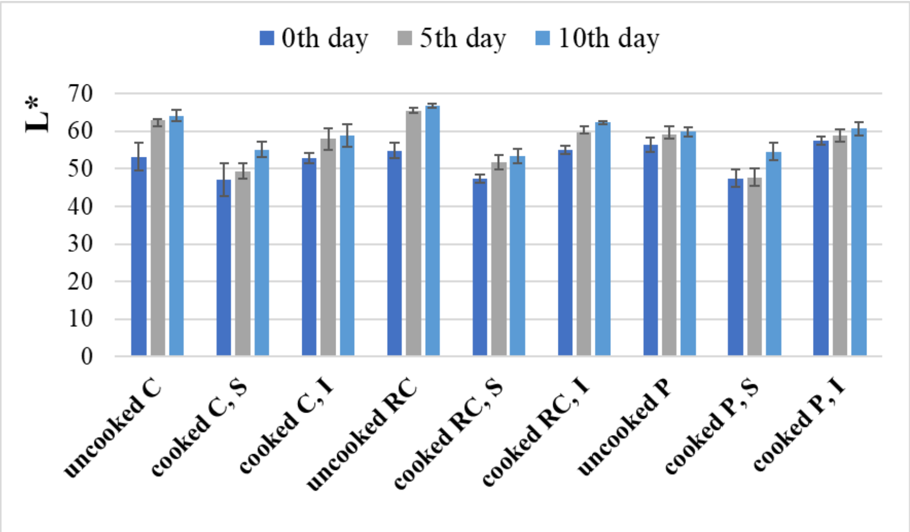

Figure 3.: L* (lightness) during storage (S=surface, I= inside)

3.5. Texture

The maximum penetration force (Figure 4.) refers to the force of biting through the sticks. RC needed the least power as it was the softest and most homogeneous sample (as also detected while tasting the sticks). C samples needed nearly two times higher force to bite through due to the peresence of chitin pieces. On the contrary, the P samples needed the highest force because of the sinewy parts of the pork meat. This dense structure also appeared during tasting as they were drier and less juicy.

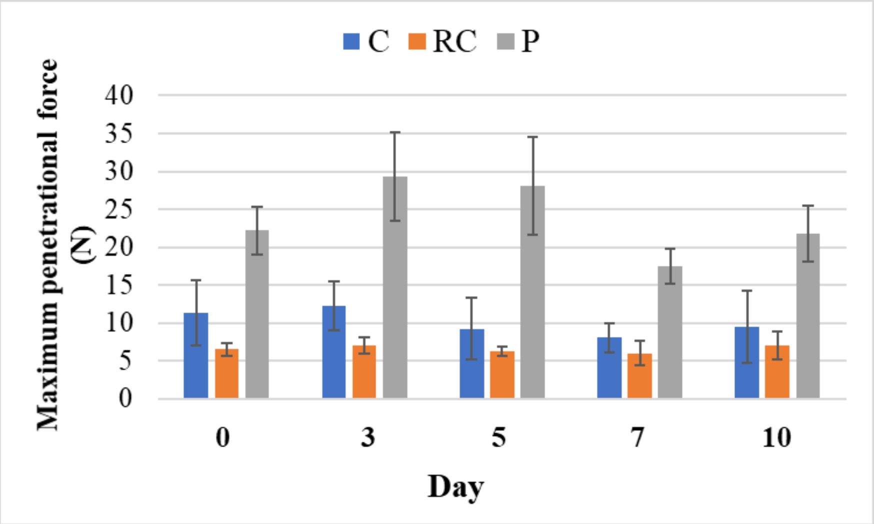

Figure 4.: Maximum penetration force during storage

3.6. Microbiological analysis

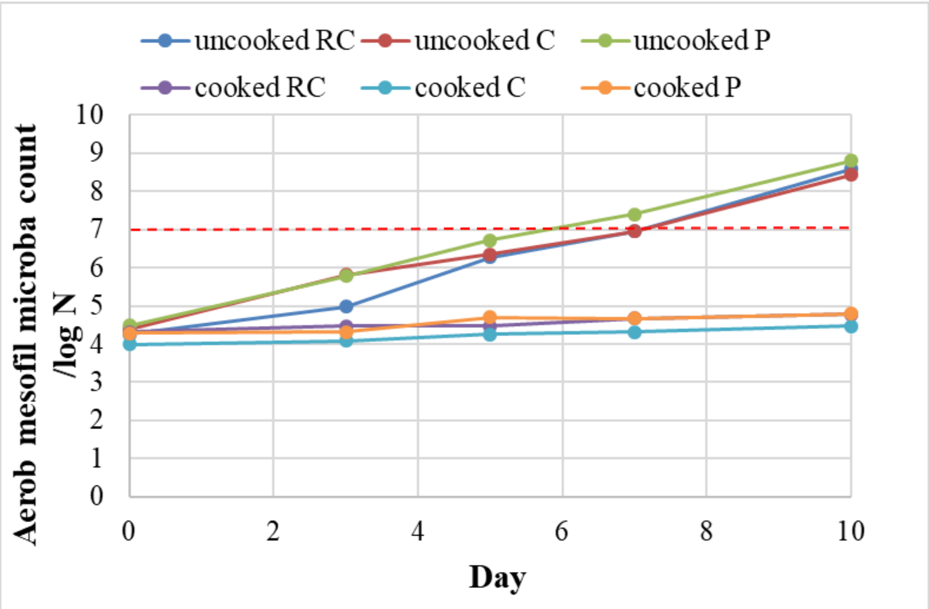

Figure 5.: Aerobic mesophilic microbe count during storage

At the begining all of the samples contained 10^4 CFU/g (Figure 5.) aerobic mesophilic microbes then this number inceased. According to the 4/1998. (XI. 11.) EüM Hungarian regulation the accepted level of microbial count in minced meat is maximum 10^7 CFU/g. The uncooked P samples reached this limit on the 6th day but the RC and C sticks on the 7th day. Therefore, the shelf-life of the insect based product was longer by one day. It is also noticable that the cooking was effective in all cases although the C sticks had less microbes with nearly 20000 CFU/g maybe thanks to the antifungal and antibacterial traits of chitin (Benhabiles,et al. 2012). This difference was proved with one way ANOVA (α=0,05): C and P: p= 0,0396 (significant), C and RC: p=0,0284 (significant), RC and P: p=0,9017 (not significant).

4. Conclusion

The colours of the samples became darker after cooking and with the progression of time. C and RC sticks had less cooking loss which refer to the more stable protein structure and the fact that the insect pastes were precooked. The water-holding capacity of C and RC samples decreased more during storage as the proteins structure disintegrated. This can be improved with a higher dosage of tetrasodium-pyrophosphate. During the texture analyses the heterogenety of the C product had an important effect on biting but the P sticks had the highest maximum penetration force becasue of the sinews. RC samples were the softest while P samples were the hardest. Lastly, the aerobic mesophilic microbial counts of uncooked sticks increased according to the same tendency but the RC and C samples were microbially safe for one more day beacause of their precooked state. After cooking the antimicrobial traits of chitin were imminent as C sticks had significantly lower microbial count. However, these results need more investigation. For example to add chitin in powdered form (from the byproduct of the chitin reducing technique) to these mixtures and then study the parameters.

In the course of this study, several advantages and a few disadvantages of the insect based hamburger sticks were revealed therefore this topic needs more research. The results contributed to the potential of insect ingredients in the food industry and it can be a starting point of further development.

Acknowledgments

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References

- Bukkens, S.G.F., (1997). The nutritional value of edible insects. *Ecol. Food Nutr*. 36, 287–319.
- Dossey, A., Tatum, J., & McGill, W. (2016). Chapter 5: Modern Insect-Based Food Industry: Current Status, Insect Processing Technology, and Recommendations Moving Forward. In A. Dossey, J. Morales-Ramos, & M. Rojas, Insects as Sustainable Food Ingredients, Elsevier, 122-145.

- Fiala, N., (2008). Meeting the demand: an estimation of potential future greenhouse gas emissions from meat production. *Ecol. Econ*. 67, 412–419.
- Finke, M.D., DeFoliart, G.R., Benevenga, N.J., (1987). Use of a four-parameter logistic model to evaluate the protein quality of mixtures of Mormon cricket meal and corn gluten meal in rats. *J. Nutr*. 117, 1740–1750.
- Godfray, H.C.J., Beddington, J.R., Crute, I.R., Haddad, L., (2010). Food security: the challenge of feeding 9 billion people. *Science* 327, 812–818.
- Grau, R., G. Hamm. (1953): Eine Einfache Methode zur Bestimmung der Wasserbindung in Muskel. *Die Naturwissenschaften.* 40(1): 277-259
- Lesnik, J.J., (2011). Bone tool texture analysis and the role of termites in the diet of South African hominids. *PaleoAnthropology* 268, 281.
- Looy, H., Dunkel, F.V., Wood, J.R., (2013). How then shall we eat? Insect-eating attitudes and sustainable foodways. *Agriculture and Human Values*
- Lundqvist, J., De Fraiture, C., Molden, D., (2008). Saving water: from field to fork: curbing losses and wastage in the food chain. Stockholm International Water Institute. Policy paper, Working brief, 20–23.
- M.S. Benhabiles, R. Salah, H. Lounici, N. Drouiche, M.F.A. Goosen, N. Mameri (2012), Antibacterial activity of chitin, chitosan and its oligomers prepared from shrimp shell waste, Food Hydrocolloids, 29/1, 48-56.
- MSZ 3640/4 — 86 (1986). Húsok és húsalapú élelmiszerek mikrobiológiai vizsgálata. Aerob mikrobák legvalószínűbb számának meghatározása folyékony tápközegben
- Thornton, P., Herrero, M., Ericksen, P., (2011). Livestock and climate change. ILRI. Available from: http://go.nature.com/wYaVA6.
- US Department of Agriculture, (2015). Agricultural Research Service, Nutrient Data Laboratory. USDA National Nutrient Database for Standard Reference, Release 28. Available from: http://www.ars.usda.gov/nea/bhnrc/ndl
- Zanolli, L., (2014). Insect farming is taking shape as demand for animal feed rises. Available from: http://www.technologyreview.com/news/529756/insectfarming-is-taking-shapte-as-demand-for-animinal-feed-rises
- 4/1998. (XI. 11.) EüM rendelet (1998) az élelmiszerekben előforduló mikrobiológiai szennyeződések megengedhető mértékéről.