SOLUTIONS FOR STORAGE LIFE AND PACKAGING OF SLICED, COOKED EGG PRODUCTS

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Abstract

The egg is still a very important source of nutrition nowadays. It is relatively easy to obtain, its nourishing, and contains nearly all of the important nutrients known. Today, many food industry processing plants prefer egg products that can go straight into the processing equipment, rather than eggs in the shell. One such ready product is cooked, shelled eggs. Companies that make egg products endeavor to perfect items that have already seen success in the market, and one way is to extend product lifetime through modern technology. In the case of sliced, cooked egg products, one such technology may be high hydrostatic pressure treatment (HHP).

For the study, packaged cooked yolk, egg white, and whole egg were cut into cubes measuring 1 cm on a side. The cubes were submerged in liquid containing table salt and citric acid (0, 0.1, 0.2, and 0.3%), and placed in durable bags. Samples were treated at both 450 and 600 MPa. All treated samples and controls were monitored during treatment for viable cell count (decimal dilution, Nutrient Agar) and general condition (cohesiveness and gumminess), as well as for changes in sensory characteristics. For that purpose we used MINOLTA CR-400 tristimulus colorimeter and Stable Micro System texture analyzer.

Based on the results, 450 MPa pressure is sufficient to reduce spore count while lengthening the time that quality is maintained. The treatment with HHP caused no noticeable changes in consistency or sensory characteristics.

Our experience is that HHP is applicable to sliced, cooked egg products, and reduces food safety risks while extending the storage time.

Key words: Hard cooked egg, HHP.

1. Introduction

Egg production, which increased rapidly following World War II, is still growing today. An estimated 72 million tons were produced in 2015, totaling no less than 1,260 billion eggs ([1], [2]). The egg has always been one of the most biologically valuable forms of human nutrition. Beside the whole egg’s considerable energy content, egg yolk contains inorganic elements (P, S, Ca, Cl, K, Na, Mg, Fe) and vitamins (A, D, B₁, B₂, E) [3]. Lysozyme, found in egg white, is effective against Gram-negative bacteria, while avidin makes vitamins resistant to bacteria [4]. The shell is considered the first line of defense against physiological and microbiological attacks, meaning its primary function is to protect the egg's precious contents [5].

The ever greater demand mentioned above has incited the industry to develop newer products featuring longer storage life and ease of handling while still conforming with the inescapable food safety standards. Egg storage life can be extended by selecting appropriate packaging material like vacuum or gas, which in the latter case generally means a ratio of 30 - 70% CO₂ and N₂. Among egg products preserved with heat treatment (cooking), the most widespread are hard-boiled eggs packed in brine, cooked whole egg sausages, egg white sausages, egg yolk sausages, and pasteurized liquid egg (whole, white, or yolk), as well as egg powder (likewise powdered whole eggs, whites, or yolks).

High Hydrostatic Pressure (HHP), is a modern, non-thermal food preservation method whose advantage is maintaining the nutritional value of the treated product [6], while simultaneously inactivating microbes. This treatment causes respectively different amounts of morphological changes in the internal and external structure of microbial cells. It may be said, however, that even at low pressure, molds and yeasts in food matrices are destroyed, while higher pressure is required
to kill bacterial cells (Gram-positive bacteria are more resistant to HHP than Gram-negative bacteria) ([7], [8]). In terms of preservation of egg products, the problem is often encountered that certain microorganisms survive heat treatment and continue to multiply during refrigeration. Up to now, according to the research, the best way to avert this problem has been a combination of heat treatment and HHP ([8], and [9]). According to some studies, high hydrostatic pressure, in combination with other methods, may be used in place of pasteurization [10].

2. Materials and Methods

2.1 Preparation and treatment of samples

The materials for the samples were obtained from the Capriovus Kft. egg processing plant located in Szigetcsép, and were packed in 500 gram sausages of: whole eggs, egg white, and egg yolk, respectively. The egg white and egg yolk sausages were plain, but the whole egg sausages were lightly salted and treated with citric acid. Cubes of 10 × 10 × 10 mm were cut from all three products.

The samples were measured out into 20 g groups, which meant an average of 7 egg cubes per group, and the sample groups were placed in heavy duty packing material filled with aqueous solution. The preservative liquid contained 1% table salt and 0.1, 0.2 or 0.3% citric acid. Three sets of 27 samples each were prepared in this way. Each set was divided into three groups: the first group became the untreated control, and the other two were subjected to 450 MPa and 600 MPa HHP pressure treatment in the Resato FPU-100-2010 hydrostatic pressure treatment system located at the Department of Refrigeration and Livestock Products Technology, Corvinus University of Budapest. Following treatment, the samples were stored at 4 °C.

2.2 Microbiological test

A viable cell count was taken once every week. One gram of sample was weighed and homogenized, and then, using the conventional Nutrient agar plate-pouring method, a tenfold serial dilution was carried out.

2.3 Texture test

After 3 weeks’ refrigeration at 4 °C, the texture of the samples was examined with a Stable Micro Systems, TA XT PLUS Texture Analyser. We applied TPA 50% pressure, which simulates human bite strength. An SMS P/35 probe was used to measure the pressure, and the test speed was 2 mm/s. Based on the test profile, we determined hardness (maximum deforming strength during the first chew cycle), and adhesiveness (amount of chewing required to reduce the product to small pieces). We compressed each sample two times with the device. Only samples kept in 0.2% citric acid aqueous solution were used, since at this concentration level organoleptic characteristics are unaffected, while microbial effect is sufficiently retarded. Figure 2 shows values read from the curve of the texture profile taken from some samples.

![Figure 1. Egg white (a) and egg yolk (b) cubes in aqueous solution containing 10 g salt and 1 g citric acid](image)

![Figure 2. Characteristics of texture profiles [11](image)
We also calculated cohesiveness and springiness of the cubes which were compressed with the SMS device. The following formula generated cohesiveness values:

\[ K = \frac{W_f}{W_i} \]  \hspace{1cm} (1)

Springiness values was determined by following formula:

\[ G = F_i \cdot K \]  \hspace{1cm} (2)

2.4 Sensory test
The sensory test method we used was a panel of experts who gave sensory evaluations. The panel, which consisted of four people, rated the quality of the samples for smell, taste, and appearance.

3. Results
3.1 Microbiological test
Viable cell count of the control samples increased during storage for all three citric acid concentrations, however the more citric acid the mixture contained, the less the microbes multiplied. This finding applies equally to the egg white (Figure 3), egg yolk (Figure 4), and whole egg cubes as well (Figures 5).

Viable cell count of the control samples increased during storage for all three citric acid concentrations, however the more citric acid the mixture contained, the less the microbes multiplied. This finding applies equally to the egg white, egg yolk, and whole egg cubes as well (Figures 3, 4, and 5). In contrast to this, viable cell count of pressure treated samples for all three products remained under 10 TKE/g concentration throughout the two week storage period. This is to say even 450 MPa of pressure proved sufficient to destroy microbes at an acceptable level. Since no noticeable changes occurred during storage (based on our results), it can be said with full confidence that pressure-treated egg products can be held for a long period of time.

3.2 Texture tests
According to our results, egg yolk has the weakest molecular convergence strength (Figure 6). However, the paired Student’s t test showed no significant difference among all samples, and even increasing the pressure did not produce noticeable changes.

In terms of springiness (Figure 7), the egg yolk samples were the “springiest” while whole egg and egg white samples closely resembled each other in this characteristic. Based on the paired t-test, it can be said that no significant difference exists in the springiness of treated and untreated egg cubes. So HHP-treatments did not influence the quality of egg products.

Figure 3. Egg white cube viable count, weeks 0 and 2

Figure 4. Egg yolk cube viable cell count, weeks 0 and 2

Figure 5. Whole egg cube viable cell count, weeks 1 and 2

Figure 6. Change in cohesiveness due to high pressure treatment
3.3 Sensory test

The rating by the panel of experts indicates no discoverable differences between the smell and color of fresh and HHP-treated samples. There were, however, minimal changes in the taste of the egg white and egg yolk cubes packed in the 0.3% citric acid aqueous solution. This is attributable not to the effect of HHP treatment, but to the concentration of acid.

We found that the taste of the whole egg sausage differed considerably from that of eggs, even at the lowest concentration. This probably is due to salt and citric acid added by equipment at the factory.

4. Conclusions

- Burgeoning egg production and processing, new customer expectations, and ever stricter food safety requirements motivate producers to widen their product ranges with newer, “gentler” processing technologies. Hidden in the production of “kitchen ready” cooked, sliced egg products is an opportunity for an excellent market, but the question of how to hold these products for extended times under industrial conditions, without using chemical preservatives, has yet to be answered.

- In our study we examined whole eggs, egg white, and egg yolk packed in aqueous solution containing a constant concentration of table salt and varying amounts of citric acid. Following 450 and 600 MPa HHP treatment, treated and control samples were refrigerated at 4 °C for three weeks. The question was what effect hydrostatic pressure has on the products' microbiological condition, texture, and sensory parameters.

- Our results clearly show that even 450 MPa treatment is capable of reaching the appropriate microbiological safety level. On the other hand, there was no effect on the texture and sensory characteristics of the products during the holding time used in the study.

5. References


