CALORIMETRIC ANALYSIS OF EGG WHITE PRODUCTS PRESERVED BY DIFFERENT METHODS

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ÖSSZEFOGLALÁS

A tojásfehérje mikrobiológiailag erősen szennyezett lehet, ugyanakkor fehérjéi hőre érzékenyek. Ezért hőkezelési hőmérsékletének és idejének megválasztásánál egy optimumkeresésre van szükség, melyben a minél nagyobb arányú mikrobapusztulás mellett a fehérjék natív állapotának megtartása a cél.
Munkánk során differenciális pásztázó kalorimetria (differential scanning calorimetry = DSC) módszerrel azt vizsgáltuk, hogy a különböző tojásfehérje hőkezelési eljárások hogyan változtatják meg a minták kalorimetrikus tulajdonságait.
Méréseink során a natív, a pasztőrözött és az 53 °C-on 24 órán át hőntartott tojásfehérje-lé termékek denaturációs hőmérsékleteiben nem tapasztaltunk szignifikáns eltérés. Ugyanakkor a rehidratált tojásfehérjepor fehérjéinek szerkezete jelentősen eltérő volt (az ovoalbumint tartalmazó csúcs 3-4 °C eltolódását tapasztaltuk).

ABSTRACT

Egg white might be highly microbiologically contaminated but its proteins are sensitive to heat. Therefore in choosing the temperature and duration of heat treatment an optimum searching is required with the purpose of maintaining native condition of proteins with the highest possible rate of microbial destruction.
In our work we tested the way the various egg white heat treatment methods affect the calorimetric properties of the samples by using differential scanning calorimetry (DSC).
Our tests have shown no significant differences in the denaturation temperature of the native, the pasteurized and the maintained at 53°C for 24 hours liquid egg white. However, the protein structure of the reconstituted egg powder was markedly different (3-4°C shift in ovoalbumin-containing peak was observed).

INTRODUCTION

Pasteurization of liquid egg white by maintaining at 60-65°C for 5 to 10 minutes is widely used in the food industry. However, numerous research are and were going on due to the risk of salmonellosis to develop safer technologies for preservation of liquid egg demonstrated by the patents registered in this field in the past decade (Davidson, 2004; Hamid-Samimi, 2000).
A method to reduce the microbiological risk can be the long term (for 24 hours) maintenance of the liquid egg white at lower temperatures (50-55 °C) tested by us previously (Németh et al., 2008). Furthermore, spray-drying of liquid egg white is also possible resulting in very stable form of egg white (Stadelman&Cotterill, 1995). However, in addition to the microbiological considerations the purpose with preservation of egg white is to maintain the favourable properties of the native egg i.e. the less possible damage of the heat-sensitive parts of the egg.
From egg components proteins are the most sensitive to heat; proteins are found in high percentage in the egg white (HammershØj et al., 2007; Rossi&Schiraldi, 1992; Gossett et al., 1984). Egg white is a protein system comprising ovomucin fibres incorporated into an aqueous solution containing numerous globular proteins. The most important representatives of these proteins – due to their ratio – include ovalbumin, conalbumin (ovotransferrin), ovomucoid, ovomucin, lysozyme and globulins (Chang et al., 1977).
DSC method has already been used several times to study thermal denaturation of egg white and its fractions (Ferreira et al., 1997; Donovan et al, 1976; Donovan et al., 1975). Particularly, it helps measuring the enthalpy of denaturation (ΔH_d) in case of egg white and some of its components, and thereby it is able to provide quantitative information. Furthermore, denaturation temperature of various proteins can also be measured with this method (Andrássy et al., 2006; Zhang et al., 2004; Mohácsi-Farkas et al, 1999).
In this study we tested the differences in the denaturation temperature of the native, pasteurized liquid egg white maintained at 53°C for 24 hours by using DSC apparatus.

MATERIALS AND METHODS

Materials

Raw liquid egg white pulled down under industrial conditions and homogenized in piston-gap homogenizer at 100 bar was used in our tests as native control sample. We tested liquid egg whites pasteurized in industrial conditions (at

60°C, 10 minutes) or maintained at 53°C for 24 hours. Furthermore, reconstituted form of spray-dried egg white powder (120 °C) was tested.

Differential Scanning Calorimeter (DSC)

Tests were performed with MicroDSC III device. Liquid egg samples were heated up from 20°C to 95°C always with increments of 1.5°C/minute.

The measured mass of liquid egg samples was 500mg ±0.1mg and water was used as reference solution. In some cases a second test cycle was also performed but no reversible phenomenon was observed.

Evaluation was performed by Seftsoft2000 program, a component of the device. The baseline denaturation temperature (the temperature at which the denaturation of fraction is started), maximum denaturation temperature (T_{max}), final denaturation temperature (the temperature above which the fraction is not denaturated) and enthalpy of egg whites preserved by different methods were tested.

RESULTS AND DISCUSSION

Endothermic phenomena observed in the liquid egg white typically correspond with protein denaturation. However, from the 4 main components of egg white (conalbumin, lysozyme, ovalbumin, globulins) association of peaks of lysozyme and conalbumin could be observed as a result of homogenization (final calorimetric peak for egg white). Onset of denaturation was observed at 60°C while the peak denaturation temperature was around 63 °C (Fig. 1.)
Our results have shown only slight changes in the first calorimetric peak of the egg white samples preserved by different methods. We did not find significant difference even after spray-drying (T_{max} decreased from 63.02°C to 62.35°C). However, while the enthalpy of pasteurized samples and samples maintained at stable temperature was unchanged, that of the egg white powder reduced from 0.3511 J/g to 0.0578 J/g.
The second peak (onset of denaturation at 70 °C) is typical to denaturation of ovalbumin and globulins. Ratio of ovalbumin in liquid egg white is significantly higher (54% of total protein) compared to that of globulins (8% of total protein); therefore, the second calorimetric peak parameters are determined by the calorimetric properties of ovalbumin. Peak denaturation temperature of these proteins was around 77°C (Fig. 2).

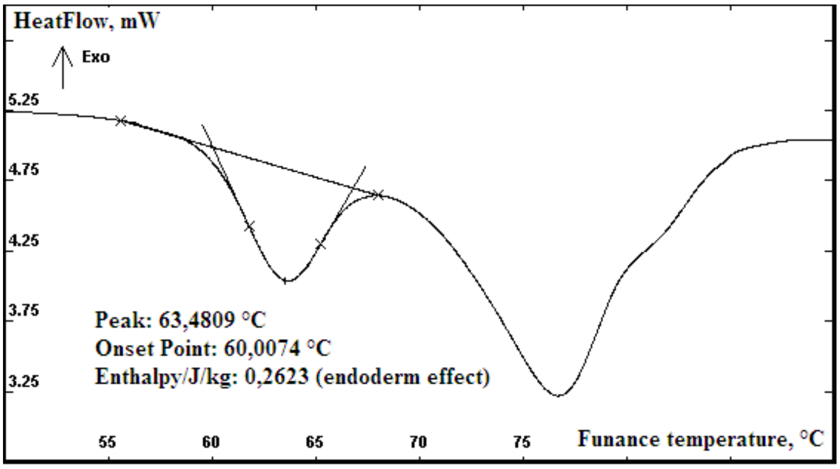

Figure 1
Evaluation of native liquid egg white (1. peak) by its thermogram

Table 1
Analysis of the first denaturation peak of the egg white products

Type of treatment	**Baseline denaturation temperature [°C]**	**Max. denaturation temperature [°C]**	**Final denaturation temperature [°C]**	**Enthalpy [J/g]**
Native sample	60.09	63.02	66.95	0.3511
Pasteurization (60°C,10minutes)	60.38	63.20	66.39	0.3409
Maintenance at stable temperature (53°C, 24 hours)	59.75	63.28	66.75	0.3447
Spray-drying (120°C)	60.83	62.35	64.62	0.0578

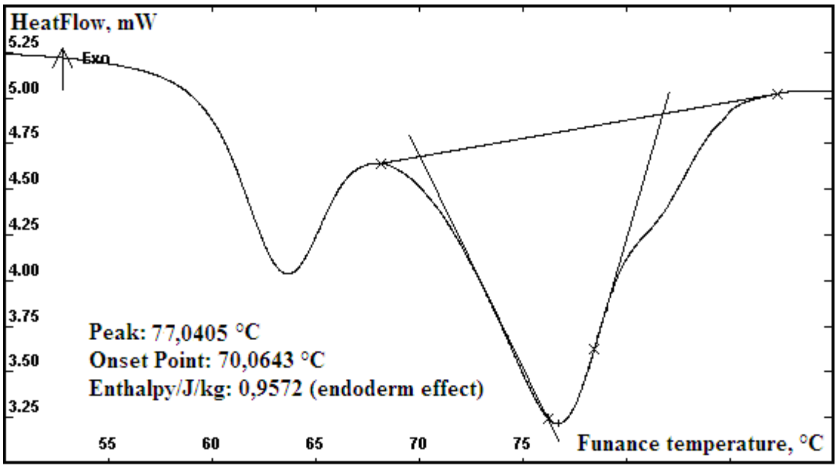

Figure 2
Evaluation of native liquid egg white (2. peak) by its thermogram

Our tests have also shown slight differences in the denaturation temperatures measured in the second calorimetric peak for native (T_{max}=76.94), pasteurized (T_{max}=77.10) egg whites and egg whites maintained at stable temperature (T_{max}=77.07). However, approximately 3-4°C shift was observed following spray-drying (T_{max}=80.81). Regarding change in enthalpy a change was observed also only with the powdered sample; its was changed from 0.9572 J/g to 0.9194 J/g.

Systematic analysis of fresh egg white has shown very good precision regarding denaturation temperature (±0.5%) and enthalpy (approx. 3%). Due to the accuracy of the applied device and large number of samples, number of errors in enthalpy values can be estimated to approx. 3% since we analyzed large, distinct peaks.

It can be concluded from our studies that both the careful pasteurization and the long term maintenance at stable temperate lower than that of pasteurization preserve the calorimetric properties of native egg white unlike that of the egg powder.

In summary, the calorimetric test method is useful for differentiation of samples preserved by careful heat treatment of liquid egg white or spray-dried and reconstituted.

Table 2
Analysis of the second denaturation peak of the egg white products

Type of treatment	**Baseline denaturation temperature [°C]**	**Max. denaturation temperature [°C]**	**Final denaturation temperature [°C]**	**Enthalpy [J/g]**
Native sample	71.25	76.94	81.64	0.9572
Pasteurization (60°C,10minutes)	71.42	77.10	82.09	0.9551
Maintenance at stable temperature (53°C, 24 hours)	71.14	77.07	81.67	0.9608
Spray-drying (120°C)	70.01	80.81	87.70	0.9194

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