Optimalization of Egg White Foam Forming

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Summary

The work was targeted on the study of egg white foam forming, the influence of pH, aluminium ionts, xanthan, maltodextrin and phosphates on the whipping and stability of egg white foams. The whipping was studied for non pasteurized and pasteurized egg white with using the blender with planet motion. Both type of egg white form good foam in acid area (pH below 4.5) and at neutral pH. The aluminium ions had positive effect on foam volume and stability especially at non pasteurized egg white. The addition of maltodextrin or saccharose decreased the volume of foam. The addition of natrium pyrophosphate or natrium hexametaphosphate had positive effect on the volume, density and stability of foam. The foams with hexametaphosphate were apllied into confectionary products.

Keywords : egg white, foam characteristics, acidity, aluminium ions, natrium pyrophosphate, natrium hexametaphosphate

Introduction

Formation of foam belongs to the most important properties of hen egg white. The egg white is used in many branches of food industry, the formation of foam is needful especially in confectionery. The quality of egg white and egg white foams is decreasing in last years. The objective of this work was to better whipping and stability of egg white foams. The quality and stability of foams have been evaluated by measuring of foaming atributes of egg white (index of whipping, index of foam durability, foam density, overrun, air phase).

The foam is two phase system in which air forms the dispersed phase and surface phase is formed by thin layer of denaturated proteins (Ternes et al., 1994). The proteins denature mechanically by whipping. Protein molecules include hydrophilic and hydrophobic groups. Hydrophilic groups are arranged in direction into liquid phase and hydrophobic groups into air phase. During whipping there are stereometric changes when the hydrophobic groups stand up on the surface, the surface energy and surface tension decrease and these effects influence the formation and stability of foam (Lomakina and Mikova, 2006a). Johnson and Zabik (1981) showed that egg white globulins had the best effect on formation of foam. Ovoalbumin, ovotransferrin, lysozym, ovomucoid and ovomucin and their interactions also participate either on foam formation or their stabilization.

The factors influencing formation and stability of egg white foam are : hen age, egg age, storage conditions, speed and time of whipping, temperature, pasterization, pH, dry matter, presence of egg yolk or lipids, salt, sugar, stabilizers and surface active matter, metal ions and proteolytic enzymes.

Materials and methods

The whipping was studied for non pasteurized and industrially pasteurized egg white. Egg white was stored at 4 °C, before whipping was tempered on 20 °C. For the assesment of whipping methods and foam formation the blender with planet motion was used. The wipping was curried out at speed grade 3 for 3 minutes. For improvement of foam formation and preservation of foam durability the impact of acidity (pH) and various aditives such as aluminium sulfate, saccharose, maltodextrin, natrium pyrophosphate and natrium hexametaphosphate were observed. All aditives were alternatively added to non pasteurized egg white and to egg white after pasterization.

For the evaluation of foams the following characteristics were used :

Index of whipping : $I_W = \frac{V_F}{V_{EW}} \cdot 100$ [%]

Index of foam durability : $I_D = \frac{V_F - V_{LEW}}{V_{EW}} \cdot 100$ [%]

Specific density : $SD = \frac{m_{100\,F}}{V_{100\,F}}$ [g·ml^{-1}]

Overrun : $O_R = \frac{m_{100\,EW} - m_{100\,F}}{m_{100\,F}} \cdot 100$ [%]

Air phase : $A_P = \frac{O_R}{O_R + 100}$ [1]

V_F… foam volume (ml)

V_{EW}…egg white volume (ml)

V_{LEW}…volume of liquid egg white 30 min. or 60 min. after whipping (ml)

$m_{100\,F}$…weighth of 100 ml foam (g)

$V_{100\,F}$…volume of 100 ml foam (ml)

m_{100EW}…weight of 100 ml egg white

Results and discussion

Influence of pH

The acidity of egg white expressed as pH value has strong influence on volume (Fig. 1 and 2) and durability of egg white foam. The highes volume and the lowest drain were how for non pasteurized so for pasteurized egg white in acid area at pH 4 and near neutral area at pH 7 for non pasteurized egg white and pH 6.5 for pasteurized egg white. The worst whipping quality of non pasteurized and pasteurized egg white was at pH 5 and at pH within the limits 7.5 to 8.5 which corresponds to common pH of egg white.

Influence of aluminium ions

Metal cations can be binded into strong complex with ovotransferrin. Ovotransferrin is contained in egg white in amount about 13 %, significantly contributes to foam formation but his denaturation started at low temperature (53 °C). Even a mild thermal treatment, e.g. the pasteurisation of egg white may cause damage to the functional properties, which is important, since ovotransferrin has the best foaming ability of all egg white proteins. But complex binding metal cation improves the protein resistance towards thermoinduced denaturation and proteolysis (Mennicken and Waterloh, 1997).

Aluminium sulphate was used for stabilisation of ovotransferrin since complex with aluminium is colourless. The addition of aluminium sulphate to non pasteurized egg white had positive effect on foam characteristics, especially volume and durability (Tab. 1, Fig. 3 and 4). The addition of aluminium sulphate to pasteurized egg white had no effect on foam volume which means that ovotransferrin was denaturated during pasteurization and did not be able to form complex more. However the durability of foam from pasteurized egg white increased after the addition of aluminium sulphate.

Tab.1. The influence of aluminium ions on egg white foam characteristics (non pasteurized egg white).

c_{Al} [g/100 g]	I_W [%]	$I_D^{30'}$ [%]	$I_D^{60'}$ [%]	SD [$g.ml^{-1}$]	O_R [%]	A_P [1]
0,0000	625,00	595,00	609,00	0,1744	486,0654	0,8294
0,0002	600,00	571,00	582,50	0,1740	474,0152	0,8258
0,0003	625,00	596,00	608,50	0,1668	498,9409	0,8330
0,0007	625,00	597,75	608,75	0,1604	522,5818	0,8394
0,0013	662,50	633,50	646,50	0,1632	512,1454	0,8366
0,0024	675,00	648,00	658,50	0,1608	521,3076	0,8390
0,0034	700,00	678,00	682,50	0,1545	546,4582	0,8453
0,0044	700,00	681,25	681,50	0,1536	550,0218	0,8462
0,0050	687,50	671,50	666,00	0,1536	550,3520	0,8462

Influence of saccharose and maltodextrin

Saccharose and maltodextrin in low concentrations (up to 3 %) were used to increase dry matter of egg white since low dry matter of egg white is one of reasons for poor quality of foam. The best concentration of egg white dry matter for whipping is 14.4±0.2 % (Lomakina and Mikova, 2006b). The addition of saccharose in all monitored concentrations to non pasteurized egg white decreased the foam volume. The addition of maltodextrin had no effect on the foam volume up to 2 %, the highest concentrations decreased foam volume too. The durability of foam increased at concentrations higher than 2 % both saccharose and maltodextrin. The addition of saccharose or maltodextrin had no effect on foam volume from pasteurized egg white, but durability of foam increased with increasing of saccharose and maltodextrin concentration.

Influence of natrium pyrophosphate

Na pyrophosphate increases pH of egg white. Because at pH higher than 9.5 the volume of foam escalated, the influence of Na pyrophosphate was tested. Results are presented in Tab. 2 and 3.

Tab.2. Influence of Na pyrophosphate on foam characteristics – pasteurized egg white.

C_{NaPP} [g/100 g]	I_W [%]	$I_D^{30'}$ [%]	$I_D^{60'}$ [%]	SD [$g.ml^{-1}$]	O_R [%]	A_P [1]
0,0000	625,00	596,25	607,00	0,1585	535,9098	0,8427
0,5002	625,00	593,75	606,00	0,1600	530,0623	0,8413
1,0002	650,00	615,75	633,50	0,1562	545,2279	0,8450
1,5001	625,00	589,75	609,00	0,1595	532,0576	0,8418
2,0000	612,50	576,50	594,50	0,1695	494,5641	0,8318
2,5002	562,50	525,50	549,00	0,1806	457,9607	0,8208
3,0003	537,50	499,50	520,00	0,1857	442,6845	0,8157

Tab.3 Influence of Na pyrophosphate on foam characteristics – non pasteurized egg white.

C_{NaPP} [g/100 g]	I_W [%]	$I_D^{30'}$ [%]	$I_D^{60'}$ [%]	SD [g.ml^{-1}]	O_R [%]	A_P [1]
0,0000	700,00	679,25	681,50	0,1533	551,7938	0,8466
0,5002	725,00	707,75	707,00	0,1467	580,7794	0,8531
1,0000	750,00	730,00	731,00	0,1487	571,7118	0,8511
1,5003	725,00	704,50	706,75	0,1565	538,5133	0,8434
2,0002	537,50	506,00	521,75	0,1986	403,0246	0,8012

The characteristics of foams from both non pasteurized and pasteurized egg white were moderately better at Na pyrophosphate concentration 1 % but improvement was not significant. The higher concentrations of Na pyrophosphate debased the quality of foams.

Influence of natrium hexametaphosphate

The addition of Na hexametaphosphate decreased pH within the limits 9.1 (blanc) to 6.7. Na hexametaphosphate significantly improved foam characteristics at non pasteurized egg white (Tab.4, Fig. 5). Within the limits of concentration 0.75 to 2.0 % the volume of foam increased about 23 % and drain after 30 min. decreased about 64 %. In the case of pasteurized egg white the observed effect was not so expressive. The volume of foam reached maximum at concentration of Na hexametaphosphate 0.5 %, at higher concentrations fell again. The drain decreased with increasing concentration of Na hexametaphosphate.

Tab. 4. Influence of Na hexametaphosphate on foam characteristics – non pasteurized egg white.

c_{HMP} [g/100 g]	I_W [%]	$I_D^{30'}$ [%]	$I_D^{60'}$ [%]	SD [$g.ml^{-1}$]	O_R [%]	A_P [1]
0,0000	600,00	575,25	584,00	0,1723	479,5218	0,8274
0,2501	725,00	710,00	707,25	0,1486	572,0831	0,8512
0,5001	687,50	680,50	672,25	0,1476	576,4496	0,8522
0,7501	737,50	730,50	723,75	0,1402	612,1470	0,8596
1,0000	737,50	728,50	721,50	0,1417	604,8674	0,8581
1,5000	737,50	728,50	722,50	0,1443	591,9905	0,8555
2,0000	737,50	722,50	718,00	0,1480	574,5941	0,8518

In conclusion, the quality of egg white foam can be improved by adjustment pH or by application of additives referred above. Results of this work are employed in egg processing industry.

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Fig. 1. Dependence of foam volume on pH – non pasteurized egg white.

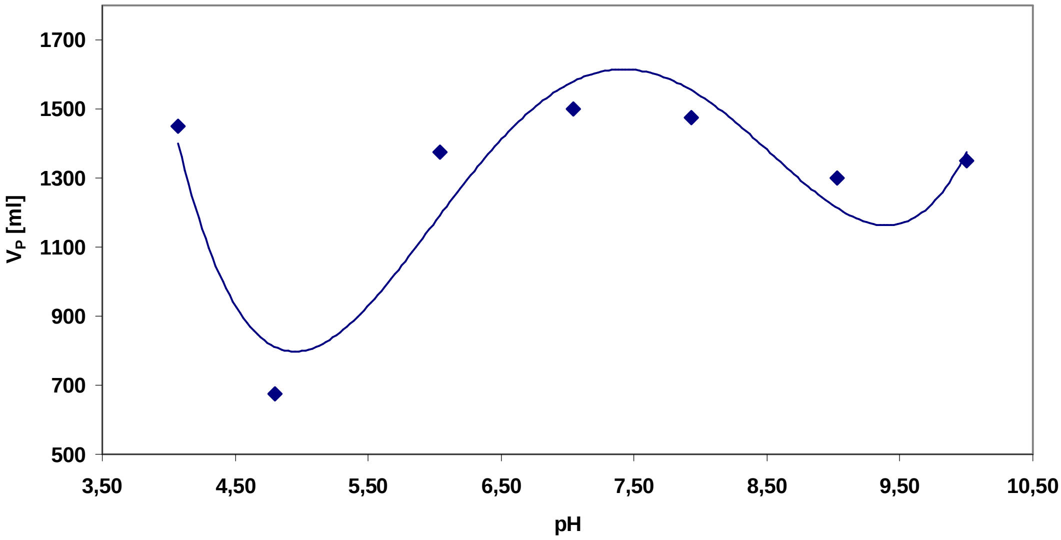

Fig. 2. Dependence of foam volume on pH – pasteurized egg white.

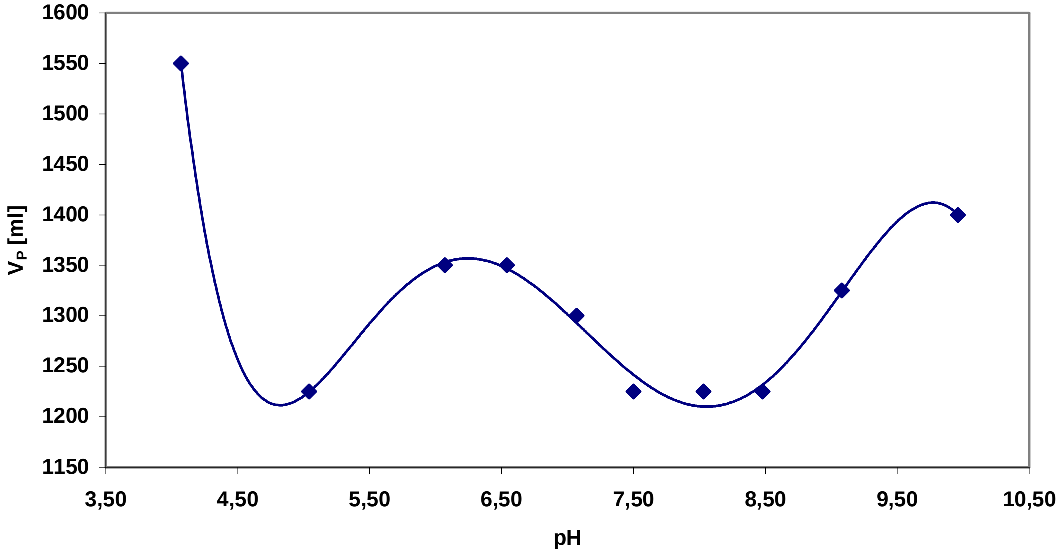

Fig. 3. Dependence of foam volume on aluminium ions concentration - non pasteurized egg white.

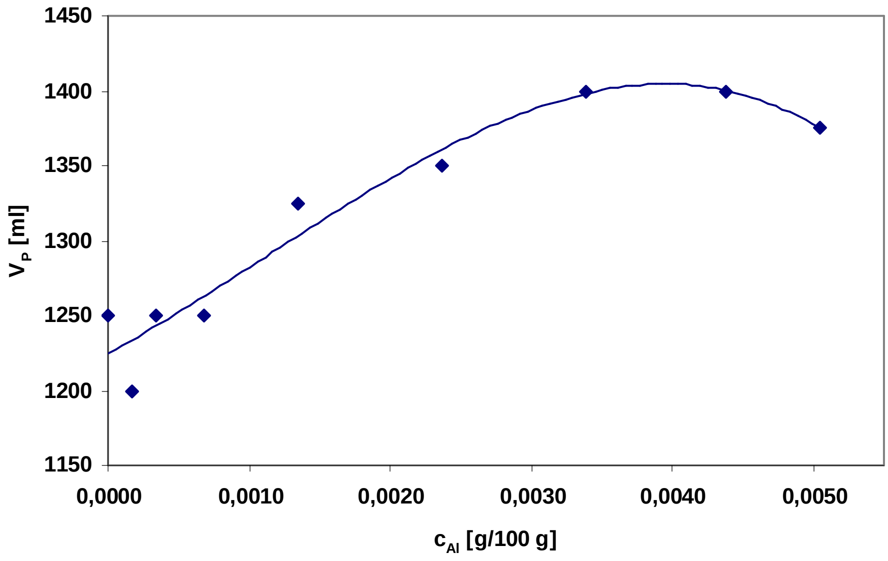

Fig. 4. Dependence of drain (30 min.) on aluminium ions concentration - non pasteurized egg white.

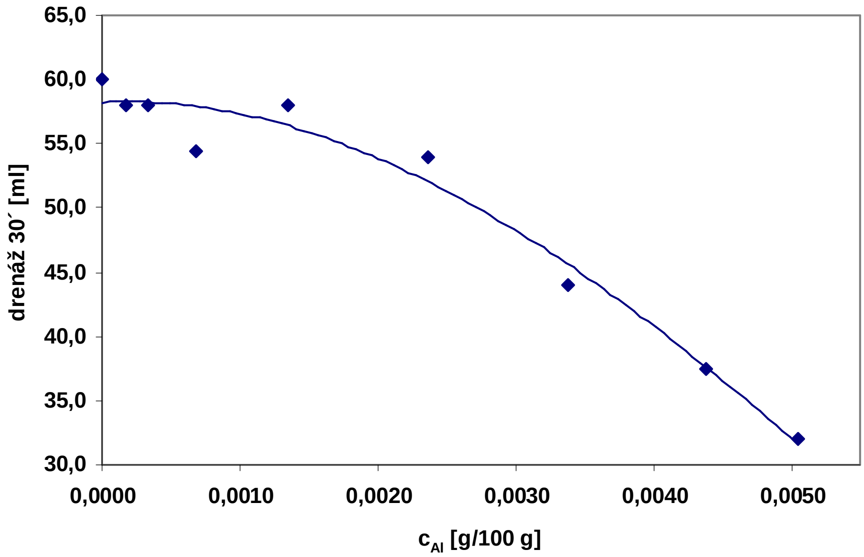

Fig. 5. Dependence of foam volume on Na hexametaphosphate concentration - non pasteurized egg white.