THE APPLICATION OF SODIUM CASEINATE IN POULTRY SAUSAGE

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PREFACE:

Sodium caseinate as an emulsifying agent added in stuffed poultry sausage will greatly improve the texture and taste, increase the output rate, and especially make full use of chicken skin, fat and other leftover ends and pieces of low grade materials. Furthermore, all the compositions are easy to mix or disperse and operation is simple.

This paper, taking chicken as object of study, designs the mix rate of pre-making emulsifying agent of casein/chicken fat/chicken skin. We explored the best pre-making condition, determined its rheological behavior and made research on its applications in poultry sausage production.

1. THE MECHANISM OF SODIUM CASEINATE IN MEAT PRODUCTS

Meat mash is a fairly compound colloid system containing protein, fat, water, salt, phosphate and so on. Fat as fine particle disperses in water system, forming a relatively stable state of emulsification.

Fat material exists in fat cells. So long as the cell-wall is not broken, fat will not separate from it. When meat is cut with increase of fineness, there will be more and more broken fat cells and more fat will separate from them. Because oil and water do not mix with each other, they tend to separate and are easily lost during boiling and fuming stage. This causes a low production yield, poor quality and bad mouth-feel of meat product.

To avoid or reduce loss of dissociated fat, one way is to make it emulsified, and this, in case of meat mash, is accomplished by protein. The dissociated fat is covered with a layer of protein numerator, forming a stable fat- protein -water system.

In meat proteins, the salt-soluble muscle-plasma-protein and muscle fiber-protein have the most vitality and emulsifying capacity. It is thought that muscle fiber protein is the first absorbed on the interaction surface of water- fat and then completes emulsification. As muscle fiber protein enters fat- water surface, its structure changes and consequently lose characteristics of network structure forming ability. By then, only the muscle fiber protein left from emulsification can form congeal glue in heat treatment, sealing fat particles and water inside it, and shows high oil- water- retention. The product is rich in elasticity, however, because of the decrease of network structure forming muscle-fiber-protein, the whole product becomes of poor histostate, low water and oil retention and low output rate. Furthermore, when using low grade poultry to produce stuffed sausages, there is much dissociated fat and water in raw material, and fiber protein is insufficient. As a result, dissociated fat, water dehydration, and poor histostate often appear.

One way to solve the problem is to add emulsifying agent in the product. Our experiments show the best one is dissociated dairy protein, such as sodium caseinate of animal protein derivatives. Caseinate can be greatly absorbed by fat-water-surface. In meat mash, casein will cover dissociated fat particles to form protein layer before muscle- fiber -protein.

As a result, muscle fiber protein will be saved and form a better network structure. This aspect is much better than the other commonly used emulsifying agent.

Secondly, the addition of sodium caseinate will help generate fine fat particles in cutting and mixing stage. They lodge in soaked and expanded muscle fiber, such lodging fat particles help to prevent muscle fiber over- contraction in heat treatment. Therefore, dissociation of water, fat and congeal glue have decreased.

The third, sodium caseinate can absorb as much as three times of water ass itself.

The forth, because casein will not congeal at normal pasteurization temperature, there is neither layer contraction nor fat separating and mixing of emulsified fat particles. Its emulsifying capacity is not affected under high temperature, and does not require rigorous temperature control during cutting stage (See Figure1).

Emulsified by sodium caseinate, the meat mash stability and texture are improved, output rate increased and processing conditions relaxed.

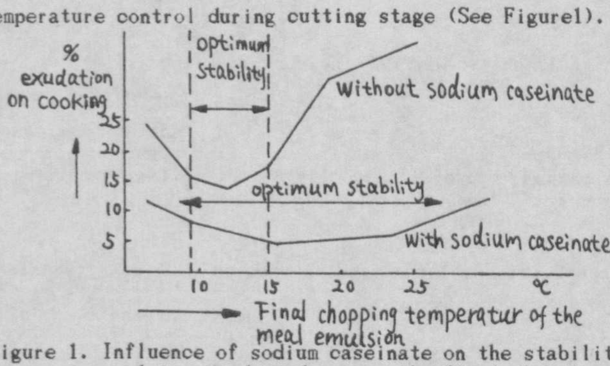


Figure 1. Influence of sodium caseinate on the stability of a meat emulsion in dependence on the final chopping temperature

2. DESIGN OF EXPERIMENT PROGRAM

The pre-making emulsifying agent can be made of sodium caseinate/chicken skins/water. The emulsion made is a kind of milk white cream We found it is a pseudo plastic fluid by determining its rheological behavior. Figure 2 shows the determining results of chicken fats emulsion (1:8:8). The fat particles are very small and even. The emulsion appears even too under an elementary microscope and has no layers after setting for some time.

The pre-making emulsifying agent is an emulsified system of oil covered by water, and the factors affecting its stability include:

(1) Ratio of raw materials; (2) Type of fats; (3) Order of raw materials added; (4) Length of time of emulsification; (5) Emulsifying temperature; (6) Volume of mechanical energy added in emulsification. Since the first two factors are affected by raw materials, we can choose to use inside organ fats and skins of fresh chickens. As for Emulsion, sodium caseinate is generally accepted. When we use high-viscosity sodium caseinate, ratio of sodium caseinate:fats (or skins): water is about 1:8~10:10~10:8. The order of input should be as such: fats (skins)—>sodium caseinate——>water. The last three factors are the important technological conditions in the making of emulsion.

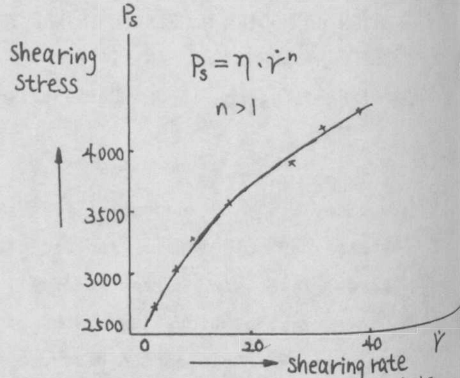


Figure 2. Viscosity of chicken fats

We designed orthogonal test program ($L_9 3^4$) of three factors and three sets of test conditions, which are given in Table 1, 2, and 3. We also studied the technological conditions in the making of emulsion of chicken fats, skins and chicken fats/skin. Selection of objective was made by measuring dehydration value or sensory test mark. (As emulsion is more stable, hydrophosic value is not easy to measure. We should make a comprehensive evaluation according to water retaining capacity, velocity, and extendibility).

Table 1. The Making of Chicken Fat Emulsion

Test \ Factor	A Temperature(℃)	B Speed of Rotation(RPM)	C Time(Min)
1	40	700	3
2	50	1000	5
3	60	1330	7

Table 2. The Making of Skin Emulsion

Test \ Factor	A Temperature(℃)	B Speed of Rotation(RPM)	C Time(Min)
1	30	700	4
2	40	1000	6
3	50	1330	8

With the optimum technological conditions found, we made an excellent emulsion, and researched and determined the manufacturing technology of chicken sausage and chicken/flesh sausage. A comparison of product quality with and without emulsion was also made.

Table 3. The Making of Skin/Chicken Fat Emulsion

Test \ Factor	A Temperature (℃)	B Speed of Rotation (RPM)	C Time (Min.)
1	40	700	6
2	50	1000	8
3	60	1330	10

3. EXPERIMENT METHOD

3.1 The making technology of emulsion

3.1.1 Chicken fats emulsion (sodium caseinate : fats: water=1:8:8)

Fresh chicken fats —>pre-cutting (1′) —>cutting (+ sodium caseinate, + water) —>30″ (+ salt) —>emulsion —>heating (100℃ 45′) —>centrifugal (3000p 15′) —>appraisal

3.1.2 Chicken skin emulsion (sodium caseinate: skins: water=1:6:6)

fresh chicken skin —>preboil —>cooling —>pre-cutting (1′) —>cutting (+ sodium caseinate, + water, + salt 30″) —>emulsion —>heating (100℃ 45′) —>centrifugal (300rpm 15′) —>appraisal

3.1.3 Chicken skin and fats emulsion (sodium caseinate: skins: fats: water=1:8:8:8)

fresh skin and fats —>preboil —>pre-cutting (1′) —>cutting (+ sodium caseinate, + water, + salt) —>30″ —>emulsion —>heating (100℃ 45′) —>centrifugal (300rpm 15′) —>appraisal

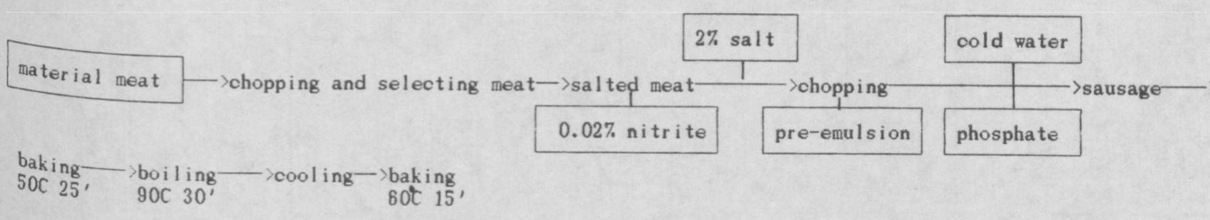
3.2 The making technology of product.

3.2.1 Chicken sausage

Formula:

thin chicken	45	cold water	14
salt	2	fats (chicken)	7
nitrite	0.02	fragrants	0.6
phosphate	0.3	skin/fats emulsion	31

Technological input order:



3.2.2 Chicken flesh sausage (added with emulsion)

Formula:

thin chicken	25	pork fats	6
thin pork	30	salt	2
phosphate	2	nitrite	0.02
emulsion	20	fragrants	0.6
starch	6	cold water	9

Technological input order: ditto.

3.2.3 Chicken flesh sausage (without emulsion)

Formula:

thin chicken	25	chicken skin	6.4
phosphate	0.3	thin pork	30
sodium caseinate	0.8	fragrants	0.6
pork fats	6	starch	6
salt	2	chicken fats	6.4
cold water	15.4	nitrite	0.02

Technological input order: ditto.

4. EXPERIMENT RESULTS

4.1 The experiment results of the making emulsion are given in Table 4, 5, 6 and the chart of visual analysis are given in Figure 3, 4, 5.

Table 4. The Orthogonal Experiment Results of Made Chicken Fat Emulsification

Factor / Test No.	A	B	C	Dehydration Value (ml)
	1	2	3	
1	1	1	1	0.90
2	1	2	2	1.00
3	1	3	3	0.70
4	2	1	2	0.80
5	2	2	3	0.50
6	2	3	1	0.80
7	3	1	3	0.60
8	3	2	1	0.55
9	3	3	2	0.90
K_1	2.60	2.30	2.25	
K_2	2.10	2.05	2.70	
K_3	2.05	2.40	1.80	
$\overline{K}_1$	0.87	0.77	0.75	
$\overline{K}_2$	0.70	0.68	0.90	
$\overline{K}_3$	0.68	0.80	0.60	
R	0.19	0.12	0.30	

Table 5. The Orthogonal Experiment Results of Made Chicken Skins Emulsification

Factor / Test No.	A	B	C	Sensory Test Mark $\overline{X}$
	1	2	3	
1	1	1	1	2.01
2	1	2	2	2.93
3	1	3	3	4.40
4	2	1	2	4.11
5	2	2	3	2.14
6	2	3	1	3.12
7	3	1	3	4.57
8	3	2	1	3.72
9	3	3	2	4.09
K	9.34	10.69	8.85	
K	9.37	8.79	11.13	
K	12.38	11.61	11.11	
$\overline{K}_1$	3.11	3.56	2.95	
$\overline{K}_2$	3.12	2.93	3.71	
$\overline{K}_3$	4.13	3.87	3.70	
R	1.02	0.94	0.76	

Table 6. The Orthogonal Experiment Results
of Made Skins/Chicken Fat Emulsification

Factor / Test No.	A	B	C	Sensory Test Mark $\overline{X}$
	1	2	3	
1	1	1	1	2.81
2	1	2	2	2.43
3	1	3	3	4.63
4	2	1	2	3.12
5	2	2	3	3.30
6	2	3	1	4.19
7	3	1	3	3.63
8	3	2	1	4.23
9	3	3	2	4.14
K_1	9.87	9.56	11.23	
K_2	10.61	9.96	9.59	
K_3	12.00	12.96	11.56	
$\overline{K}_1$	3.29	3.19	3.74	
$\overline{K}_2$	3.54	3.32	3.23	
$\overline{K}_3$	4.00	4.32	3.85	
R	0.71	1.13	0.62	

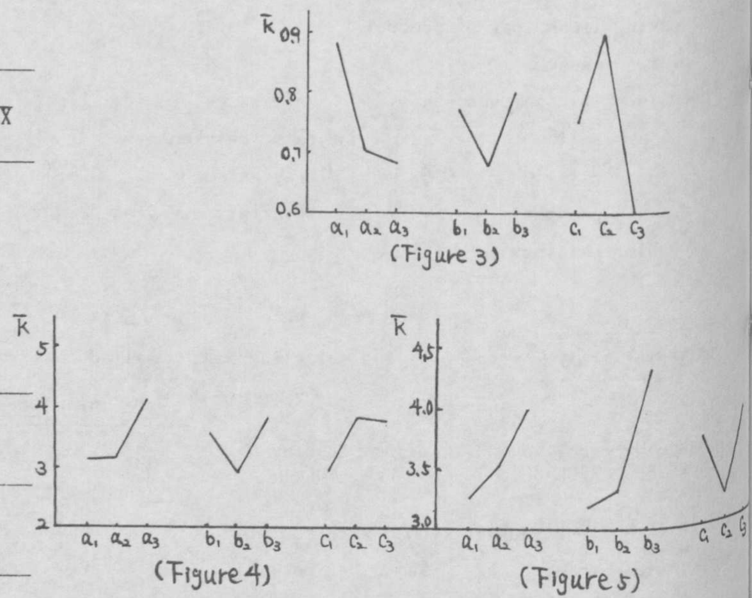


Figure 3, 4, 5 Visual Analysis of orthogonal experiment

From table 4 and figure 3, we conclude that the optimum technological condition of making chicken fats emulsion is of $A_3 B_2 C_3$ and 80 °C, 1000 rpm, 7 minutes.

From table 5 and figure 4, we conclude that the optimum technological condition of making skin emulsion is of A_3 $B_3 C_2$ and 50 °C, 1330 rpm, 6 minutes.

From table 6 and figure 5, we conclude that the optimum technological condition of making skin/chicken fats emulsion is of $A_3 B_3 C_3$ and 60 °C, 1330 rpm, 10 minutes, and skin and emulsion have the highest viscosity and best water retaining capacity.

4.2 The organoleplic investigation of chicken and chicken/flesh sausage and relate yield and elastic force recovery values are given in Table 7.

Table 7. Results of Organoleptic Investigation and the Value of Physical Determination

Target / Kind	Section	Outside Appearance	Taste and Flavor	Color	Yield Value* (g/cm²)	Elastic Force Recovery Value (%)
Chicken Sausage	Fine and Smooth	Fair	Tender, Offensive Chicken Smell	Milk White	307-420	81.6
Chicken/Flesh Sausage (with (Emulsification	Fine and Smooth	Fair	Tender, less Offensive Chicken Smell	Light Red	291-430	86.5
Chicken/Flesh Sausage (no (Emulsification	Coarse	Has separated oil	Greatest Offensive Chicken Smell	Red	274-291	92.1

* determined by universal rheological instrument made in Japan and recorded in Figure 6.

From table 7, we learnt that products with pre- making emulsifying agent added tend to have a smooth section, but soft mouth-fell, less offensive chicken smell and no separated oil. The third kind is flexible and easy to crash but hard to break, while the first and the second ones are harder but easy to cut. Their chewing taste is better than the third kind.

5. CONCLUSION

From the above analysis, we make the following conclusion:

(1) The effect that sodium caseinate be applied in pre-making emulsifying agent in poultry sausage is apparent and favorable. Application of inferior materials and leftover bits and ends is feasible, effective and successful.

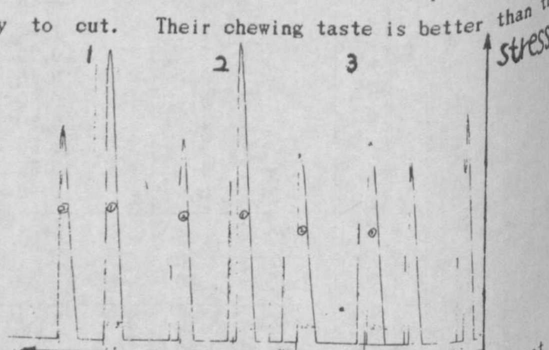


Figure 6. Chart made with universal rheological instrument

A. Chicken fats emulsion 80 °C, 1000 rpm, chopping 7 minutes
B. Skins emulsion 50 °C, 1330 rpm, chopping 6 minutes
C. Skins/chicken fats emulsion 60 °C, 1330 rpm, chopping 10 min.
(3) Skins/chicken fats emulsion has the best effect and is recommended.

(2) The optimum technological conditions of the three pre-making emulsifying agents are:

6. REFERENCES

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(2) J. Jong. Sma, 'New Possibilities for Milk Protein Emulsions'
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