EFFECT OF THE RINDS COOKING METHOD AND A SECOND CHOPPING PROCEDURE ON THE STABILITY OF RIND AND FAT EMULSIONS

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SUMMARY

Rinds cooking method influences the stability of soy isolate and Na-caseinate rind and fat emulsions. The method ran under pressure (pressure cooker - 113°C) is more efficient than the one operated at atmospheric pressure (100°C). This fact is mainly observed for short cooking times.

In both methods, Na-caseinate emulsions revealed a maximum stability level at extended cooking times than soy isolate emulsions. In addition the former emulsion exibited higher sensitivity to this technological parameter.

The influence of a second chopping processing in Na - caseinate emulsions is positive for all assay conditions used, being the results dependent on the rinds cooking method for soy isolate.

INTRODUCTION

Most research concerning meat emulsions stabilty studied the replacement of meat protein by other vegetable and animal proteins of different purity level and technological preparation processing (**Smith, et al., 1973; Lauck, 1975; Lin et al., 1975; Tornberg and Hermansson, 19 Ozimek and Poznanski, 1981; Simard, et al., 1983; Bianchi, et al., 1985**).

Non-meat proteins can be directly added to finely comminuted meat systems. However, this addition usually takes place after the previous preparation of fat emulsions due to obvious technological advantages (**Hoogenkamp, 1979; Zayas, 1985**). The thermal stability (the most important physical characteristic) is basically dependent on the ratio of raw material elements but, many other production aspects, such as: 1- design and emulsification efficiency of the equipment; 2- emulsification temperature and time; 3- type of salt added; 4- raw material addition order in processing are extremely important parameters (**Ackerman, et al., 1971; Webb, et al., 1975; Schut, 1976; Tornberg, 1979; Jones and Mandigo, 1982; Voutsinas, al., 1983; Aoki, et al., 1984**).

Little information in this area is available, due to the lack of studies at pilot plant scale. Therefore, there is a limitation on the direct application of many laboratorial results (**Circle and Smith, 1972; Kinsella, et al., 1979; Aoki, 1980**). In most meat processing plants, pre-emulsions are prepared using a bowl chopper, being also an usual practice the utilization of cooked rinds as an additional emulsifying and stabilising agent.

Bearing in mind these technological conditions, the purpose of this work was to study the effect of time and temperature of rinds cooking and a second chopping processing on the stability either of soy isolate, Na-caseinate rind and fat emulsions.

MATERIAL &METHODS

Reference proteins - Soy protein isolate (**SPI**) was purchased as IPSO-MR from Vaessen Schoemaker Chemische Industrie B.V.-Holand, with composition of protein, 85.9%; water content, 8.5%; ash, 3.85; pH 7.1 (solution 1%). Na-caseinate (**Na-Cas**) was purchased from the same enterprise as BINDOX 050-low viscosity, with a content of protein, 90.8%; water content, 2.7%; ash, 4.2%; pH 7.5 (solution 1%). Proximate analyses were determined according to standard AOAC methods. For pH evaluation, a Metrohm 654 with a combined glass electrode was used. All solutions were prepared by using type I deonized water.

Fat - Whole pork back fat from randomly chosen animals (carcass weight between 70-90 Kg), was previously minced in a bowl chopper (2x2 mm particle size), blended, deep frozen at -40°C and stored at -18°C in plastic bags, each containing aproximately 0.60 Kg, until required for processing.

Rinds- Only the rinds containning lard, were used. In order to reduce the influence of its great fat content variability in the experimental results, they were previously hand cuted (1x2 cm pieces), prepared and stored in the same conditions as refered above.

Emulsions water- Water used in the preparation of emulsions was obtained at the rinds cooking step. The water:rinds ratio was kept constant for all experiments (420 g of rind pieces were boiled in three liters of tap water).

Emulsion preparation- A six knives bowl chopper EMS-MTK 10 with dual plate (12.5 and 25 rpm) and knives (1400 and 2800 rpm) rotation speed were used.

Rinds were chopped imediatelly after cooking at high speed for two minutes. In a subsquent phase, fat, protein and water (95°C) were added at low speed, followed by eight minutes chopping at maximum speed. Emulsification temperature was measured one minute after operation at the latter conditions.

When an emulsification temperature around 50°C was required, the bowl chopper plate was heated with boiling water, three minutes before emulsion preparation.

For this study, a 1:9:20:6 (protein: fat: water: rinds) formulation was used. Emulsion pH was found to remain unchanged during the course of the assays, filling all the ingredients half volume of the bowl chopper capacity. Emulsions were placed into 25x100 mm plastic top stoppered centrifuge tubes (45 g), and 70x35 mm metalic cans (145 g), for pasteurization (90°C -45 min) and sterilization (120°C - 45 min), respectively.

Stability determination - The method of Tornberg and Hermansson (1977) was modified as follows: 1 - Samples were kept in containers for 24 hours at 4°C, before thermal processing; 2 - Determination of fat contet in untreated emulsions (**Fo**) by using the Babcock "modified" method (**Santos, C. et al., 1984**) taking 3 and 9 g from the bottom of centrifuge tubes and cans (bottom horizontal layer), respectively; 3-Determination of fat concentration in thermal treated emulsions (**F**) after 24 hours at 4°C storage temperature, using the same methology described above; 4 - Emulsion stability (**E.S.**) was calculated as follows:

$$E.S.\ (\%) = \frac{F}{Fo} \times 100$$

Each **Fo** and **F** values represents the average either of 3 and 4 replicates, for pasteurized and sterilized emulsions, respectively.

Hardness determination - Rinds gell hardness was evaluated at 5°C by texture profile analysis, with a J.J. Instrument Universal Texturometer, forcing a 12 mm diameter flat bottom rod through the material (4 cm deep), at 200 mm/min, using a 50 N cell.

Effect of Rind Cooking Method - Rinds cooking took place either at atmospheric pressure (**AP-100°C**) or under high pressure by using a pressure cooker (**PC-113°C**). Cooking time was evaluated from the start of boiling (15; 30; 45 and 60 min) and pressure scape (10; 15; 30 and 45 min), respectively. All the assays were ran using the emulsifying method described above, with the previous heating of the bowl chopper plate.

Effect of a second chopping procedure - Emulsion cooling took place overnight in a thin layer (≈ 4 cm deep) followed by chopping operation at high speed during two minutes, corresponding to an increase in the initial temperature from 5°C to 12°C. The objective was the simulation of pre-emulsions behaviour when added to comminuted meat systems.

Data Analysis - Second order polynomial fitting of the data was made using cricket graph software (Cricket Graph Software, Inc.).

RESULTS &DISCUSSION

Rinds cooking temperature and time - For technological reasons, rinds added to pre-emulsions are previously cooked. However, cooking temperature and time are not standardized in most meat plants. The major physicochemical modifications that take place in struture and composition of colagen (**Goll, et al., 1964; Snowden and Weidmann, 1978**) imply changes on its functional behaviour in the development and stabilization of emulsions. The final result is however dependent on the functionality of the main emulsifying agent used, as well as the later thermal processing (**Fig. 1 and 2**).

The pasteurized **SPI** emulsions stability was not greatly affected by the coking time either in **AP-100** or **PC-113** methods . Nevertheless, for times between 15 and 30 minutes, the stability values were always slightly higher for **PC-113** than **AP-100**, being not significantly different for 45 minutes. Stability of sterilized emulsions is significantly affected by rinds cooking time. For **AP-100** method a direct relationship was found between 15 and 45 minutes, decreasing afterwards until 60 minutes. Regarding **PC-113**, the same characteristic was obtnained, being the higher stability rate faster, at around 15 minutes of cooking (**Fig. 1**). At similar cooking times, this method showed higher efficiency than **AP-100**, mainly at shorter times.

Na-Cas pasteurized and sterilized emulsions showed a much higher dependence on cooking time, specialy in the case of **AP-100**. In this conditions, stability values strongly increase for the complete cooking time range, being relevant the increase of the percentual rate, observed between 15 and 30 minutes (**Fig. 2**). **PC-113** method did not greatly affect the emulsion stability between 10 and 30 minutes, being the highest value around 25 minutes. The extention of cooking time up to 45 minutes, resulted in a drastic (- 60%) loss in emulsion stability. As for **SPI** sterilized emulsions, this cooking method showed higher efficiency (exception to 45 minutes), mainly for the lower equivalent cooking time (15 minutes).

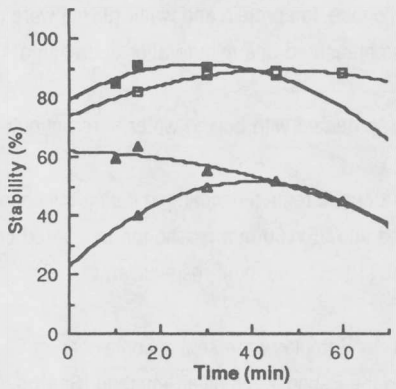

Fig. 1 - Influence of rinds cooking method on the **SPI** fat emulsions stability. Processing conditions used: standard emulsification processing, 50°C emulsification temperature and 8 min emulsification time

- ■ **90°C - 45 min PC-113**, $y=79.5545+0.8513x-0.015x^2$ R=0.77
- □ **90°C - 45 min AP-100**, $y=73.850+0.6807x-0.0073x^2$ R=1.00
- ▲ **120°C - 45 min PC-113**, $y=61.9409-0.018x-0.0047x^2$ R=0.89
- △ **120°C - 45 min AP-100**, $y=22.750+1.4373x-0.0178x^2$ R=1.00

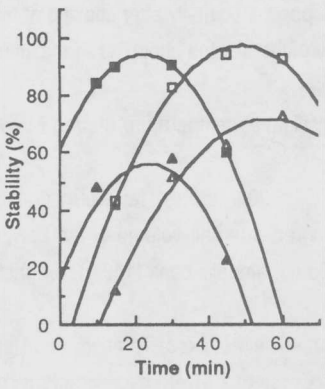

Fig. 2 - Influence of rinds cooking method on the **Na-Cas** fat emulsions stab... Processing conditions used: standard emulsification processing, 50°C emulsific... temperature and 8 min emulsification time.

- ■ **90°C - 45 min PC113**, $y=61.0803+2.9707x-0.0662x^2$ R=1.00
- □ **90°C - 45 min AP-100**, $y=14.2000+4.5680x-0.0467x^2$ R=1.00
- ▲ **120°C - 45 min PC-113**, $y=15.3424+3.4313x-0.0719x^2$ R=0.89
- △ **120°C - 45 min AP-100**, $y=36.7000+3.8447x-0.0340x^2$ R=0.99).

Cooking times referred as showing maximum stability, can be longer in practice conditions, due to the rinds preparation processing condi... used in this study. **Snowden and Weidmann (1978)**, reported that denaturation of colagen depends on the mechanic damaging degreee of raw mate... starting this process by the fibrils ends.

It was reported that thermal denaturation of colagen is directly proportional to the temperature and time of heating (**Goll et al., 1964**). Th... findings were confirmed during the present study through the inverse relationship found between cooking time and rind gel hardness, as well as ... increasing protein content in cooking water (**Table I and II**). However, while the first relationship was followed by an increase of rinds water absorpt... **AP-100** for all range of cooking time, in **PC-113** this water uptake was less expressive between 10 and 30 minutes of cooking, decreasing a... minutes. For a similar denaturation level (16N of hardness), rinds cooked by **PC-113** method showed aproximately a half of the **AP-100** wa... absortion capacity. According to **Pearson and Tauber (1984)**, rinds show a defficient water holding capacity and emulsifyng ability on heating, cau... by melting and gelatinization. This difference in rinds water absortion could be the explanation for **PC-113** higher efficiency in final emulsion stab... for lower cooking times.The influence of those technological factors in **SPI** and **Na-Cas** emulsions stability might be, in part, understood on the cont... of the functional behaviour of these proteins. According to **Tornberg (1979)** and **Aoki et al., (1984)**, protein emulsion ability is basically influenced by... by the difusion rate to the interface and, its behaviour after adsorption. **SPI** proteins show a lower solubility index and emulsion capacity (**Santos ... al., 1989**) and lower difusion rate in the continous phase than **Na-Cas** proteins (**Tornberg, 1979**). Rinds colagen denaturation level got at 45 minutes ... **100** and at 15 minutes **PC-113** allows the ocupation of **SPI** emulsion interface by their polipeptide chains, decreasing the final emulsion stability. For **... Cas**, because of the great hability of their proteins to interface adsorption, that phenomenum is only seen at 45 minutes **PC-113.**

Influence of a second chopping procedure - The influence of this technological parameter on sterilized **SPI** and **Na-Cas** emulsions stability prepared ... **PA-100** and **PC-113** rinds cooking methods are shown in **Fig 3** and **4.**

While for **Na-Cas**, with exception of 45 minutes in **PC-113** an increasing in the stability was obtained for any operational conditions, in **SPI** ... results were dependent on cooking time for **AP-100**. In this case, with the increasing of the emulsion stability seen at 15 minutes, the results previou... obtained untill 45 minutes of cooking time became quite stable and not significantly different. At 60 minutes, a significant decrease was obser... Additional chopping time and the dehydration ocurred during emulsion storage time as well (+ 2% in **Fo** values) can also be responsible for the hig... stability found.

CONCLUSIONS

Accordind to the results it can be conclude that rinds cooking method significantly affects the stability of **SPI** and **Na-Cas** fat emulsions.

The sterilized **Na-Cas** emulsions are more sensitive than similar **SPI** in the tested range of cooking times and temperatures.

SPI emulsions, for both cooking methods, reached the highest stability at short cooking times when compared to **Na-Cas** emulsions.

PC-113 method, with exception of **Na-Cas** emulsions prepared at 45 minutes of cooking time, is more efficient than **AP-100**, regarding emulsi... stability.

A second chopping procedure influences positively **Na-Cas** emulsions stability, while the results for **SPI** depend of the rinds cooking time for ... **AP-100** method.

Table I. Modifications of rinds chemical composition and gell hardness during cooking processing by AP-100 method.

Time (min)	Water Absortion		Protein(%)		Hardness (N)
	Initial weight (g)	Final weight (g)	Cooking water	Rinds	Rinds pure
15					
30	100.5	105.7+ 5.0%	0.200	25.0	52
45	101.8	108.1+ 6.2%	0.277	25.4	40
60	100.2	107.5+ 7.3%	0.360	23.8	30
	100.0	112.8+12.8%	0.375	22.5	16

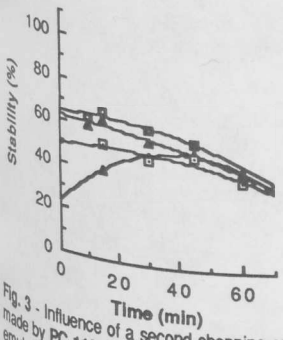

Fig. 3 - Influence of a second chopping on the stability of **SPI** sterilized fat emulsion made by **PC-113** and **AP-100** cooking methods. Processing conditions used: standard emulsification method, 50°C emulsification temperature and 8 min emulsification time.
- ■ **2nd chopping PC-113**, $y=63.7742+0.1753x-0.0074x^2$ R=0.92
- ⊡ **2nd chopping AP-100**, $y=48.9500+0.2287x-0.0060x^2$ R=0.88
- ▲ **120°C - 45min PC-113**, $y=61.9409-0.0180x-0.0047x^2$ R=0.89
- △ **120°C - 45 min AP-100**, $y=22.7500+1.4373x-0.0178x^2$ R=1.00

Table II. Modifications of rinds chemical composition and gell hardness during cooking processing by PP-113 method.

Time (min)	Water Absortion		Protein(%)		Hardness (N)
	Initial weight (g)	Final weight (g)	Cooking water	Rinds	Rinds pure
10	130.7	136.8+4.7%	0.27	26.8	26
15	131.1	140.1+6.9%	0.27	25.1	16
30	131.3	141.1+7.8%	0.26	24.6	12
45	131.0	138.5+5.7%	0.39	23.5	10

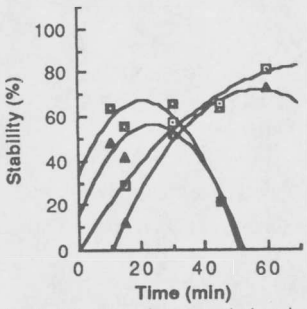

Fig. 4 -Influence of a second chopping on the stability of **Na-Cas** sterilized fat emulsions made by **PC-113** and **AP-100** cooking methods. Processing conditions used: standard emulsification method, 50°C emulsification temperature and 8 min emulsification time.
- ■ **2nd chopping PC-113**, $y=33.7197+3.2127x-0.0771x^2$ R=0.95
- ⊡ **2nd chopping AP-100**, $y=0.0500+2.2273x-0.0149x^2$ R=0.99
- ▲ **120°C - 45 min PC-113**, $y=15,3424+3.4313x-0.0719x^2$ R=0.89
- △ **120°C - 45 min AP-100**, $y=-36.700+3.8447x-0.0340x^2$ R=0.99

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