MODIFICATION OF RONGEY'S METHODOLOGY FOR ESTIMATING THE STABILITY OF MEAT BATTERS

Sarah E. Bludau[1], Rachel I. Crowley[1,2] and Rodrigo Tarté[1,2*]

[1]Department of Animal Science, Iowa State University, United States

[2]Department of Food Science and Human Nutrition, Iowa State University, United States

*Corresponding author email: rtarte@iastate.edu

I. INTRODUCTION

Since it was first proposed in 1965, the Rongey method [1] has been used routinely by many research [2, 3, 4] and industry [5, 6] laboratories around the world for estimating and quantifying the thermal stability of meat batters or emulsions. The method consists of placing the raw meat batter inside specially-designed and -fabricated tubes (referred to as Wierbicki tubes), followed by heating to cook the batter, and centrifugation to separate free liquids. Its usefulness results from the tube's design, which allows complete separation of the free water and lipid fractions during centrifugation, as well as precise quantification of each. However, the tube's unique design and relatively large size pose a challenge to the method's adoption by many laboratories today, given the need for specialized glassworks and a centrifugation unit with a larger rotational radius larger than that of most presently-available commercial benchtop centrifuges. Therefore, our objective was to modify Rongey's experimental method using commercially-available centrifugation equipment and glassware, without sacrificing its simplicity, accuracy and usefulness.

II. MATERIALS AND METHODS

Batches of pork batters were made by combining 2268 g pork trimmings of varying fat content (3%, 24%, 67%) and 454 g ice/water mixture, in a 2 x 2 x 2 factorial design, with two levels of target fat (FAT: high fat [27%]; low fat [10%]; on meat basis), two levels of salt/phosphate addition (SPH: 1.8% salt + 0.5% sodium tripolyphosphate; no salt/phosphate) and two batter stability experimental methods (METHOD: Rongey; modified Rongey). The lean pork was comminuted with ice, salt and phosphate in a bowl chopper for 1 min, after which the fat trimmings were added and chopping continued to 11.1 °C. Portions of each batter were then inserted into each of 10 Wierbicki tubes (traditional Rongey method, 25 ± 1 g per tube) and each of 10 Kimax no. 45165 glass centrifuge tubes (modified Rongey method; 15 ± 1 g per tube), heated in a water bath at 71 °C for 30 min, allowed to cool at room temperature for 5 min and centrifuged at 300 x *g* for 5 min at room temperature. The Wierbicki tubes were centrifuged in an old Chicago Surgical & Electrical model 61 centrifuge (Labline Inc., Chicago, IL, USA) and the Kimax tubes in a Thermo Scientific Sorvall Legend X1R centrifuge (Thermo Electron LED GmbH, Osterode am Harz, Germany) equipped with a Thermo TX-400 rotor and Thermo 75003655 buckets. After centrifugation, aqueous and lipid layers were read from the lower, graduated, part of each tube, and released water and lipid were calculated on a v/w basis. The experiment was designed as a randomized complete block (RCBD), with factors FAT and SPH arranged in a split block and factor METHOD in a split plot relative to FAT and SPH. It was replicated three times and results were analysed as a mixed model using JMP Pro 16.2, with statistical significance set at $P < 0.05$.

III. RESULTS AND DISCUSSION

P values of main effects and their interactions are shown in Table 1. The FAT x SPH interaction effect was significant for water and lipid release, with both being, expectedly, lower when salt/phosphate were added. While in the presence of salt/phosphate they were not different, in the absence of salt/phosphate they were higher in the high-fat than in the low-fat treatment, indicating that under these conditions the high-fat batter was less stable than its lower fat counterpart. The lack of a significant three-way (FAT x SPH x METHOD) interaction reveals that the batter stability analysis method played no part in these observed effects and that both methods had equivalent performance, regardless of the fat level of the batter. The SPH x METHOD interaction was significant for released water, but not for released fat. When salt/phosphate were added, released water, regardless of method, was lower than in their absence. However, in the absence of salt/phosphate, released water was higher for the Rongey method than for the modified method (27.7% v. 22.7%, respectively; $P < 0.05$), a difference that was driven by higher water release in the Rongey method at low fat (Table 2).

Table 1. P values of fixed main effects and interactions of released liquids from cooked pork batters.

	Main effects[1]			Interaction effects			
Dependent variable	FAT (F)	SPH (S)	METHOD (M)	F × S	F × M	S × M	F × S × M
Released water, %	0.002	0.002	0.003	0.022	0.192	0.007	0.349
Released lipid, %	0.050	0.037	0.930	< 0.001	0.318	0.593	0.274

[1] FAT: fat level (high; low); SPH: salt & phosphate added (no; yes); METHOD: batter stability method (Rongey; modified)

Table 2. Least squares means[1] for water and lipid released from pork batters, as affected by fat level and addition of salt and phosphate, as measured by two different emulsion stability analytical methods.

Fat level	Salt/phosphate addition	Released water (%)		Released lipid (%)	
		Rongey	Modified	Rongey	Modified
High	Yes	4.6[c]	5.8[c]	0.8[b]	0.9[b]
High	No	29.3[a]	24.6[ab]	9.3[a]	8.3[a]
Low	Yes	6.4[c]	4.4[c]	0.5[b]	0.6[b]
Low	No	26.1[a]	20.8[b]	0.6[b]	1.1[b]

[1] n = 30 (10 tubes/batch x 1 batch/replication x 3 replications)

[a-d] Within liquid type (across method), means with different letters are significantly different ($P < 0.05$).

IV. CONCLUSION

The proposed modification of the Rongey methodology yielded results comparable to those of the original method. Its use of commercially available centrifugation equipment and glassware makes it more accessible to the greater meat science research community.

ACKNOWLEDGEMENTS

This work was supported by the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa, USA, Project No. IOW04121, which is sponsored by Hatch Act and State of Iowa funds.

REFERENCES

1. Rongey, E. H. (1965). A simple objective test for sausage emulsion quality. In Proceedings Meat Industry Research Conference (pp. 99–106), Chicago, IL, USA. Arlington, VA: American Meat Institute Foundation.
2. Bater, B. & Maurer, A. J. (1991). Effects of fat source and final comminution temperature on fat particle dispersion, emulsion stability, and textural characteristics of turkey frankfurters. Poultry Science 70: 1424–1429.
3. He, Y. & Sebranek, J. G. (1996). Frankfurters with lean finely textured tissue as affected by ingredients. Journal of Food Science 61: 1275–1280.
4. Tarté, R., Paulus, J. S., Acevedo, N. C., Prusa, K. J. & Lee, S. (2020). High-oleic and conventional soybean oil oleogels structured with rice bran wax as alternatives to pork fat in mechanically separated chicken-based bologna sausage. LWT - Food Science and Technology 131: 109659.
5. Bolin, H., Bacus, J. N. & Barhaug, R. O. (1983). Sausage emulsions containing gluconate salts and process of preparation (U.S. Patent 4,382,098). U.S. Patent and Trademark Office.
6. Trautman, J.C. (1970). Method of extracting salt soluble protein from post-rigor meat (U.S. Patent No.3,523,800). U.S. Patent and Trademark Office.