CONTROL OF COOKING LOSSES AND TEXTURE BY USING EMULSION TEMPERATURE AND REFLECTION PHOTOMETRY IN FRANKFURTERS MANUFACTURED WITH DIFFERENT FAT AND STARCH LEVELS.

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Introduction

Chopping process is a critical stage in frankfurters manufacturing that exert a large impact on essential gel properties (e.g., cooking loss, gel texture). Overheating during the emulsification leads to emulsion breakpoint, which increases cooking loss (*CL*). Thus, chopping time/speed and emulsion temperature (*T*) must be controlled to prevent undesired losses of yield and quality in frankfurters. According to previous studies (Barbut 1998; Álvarez et al., 2007), *T* was not always the most accurate chopping end-point predictor, especially in reduced fat meats. These authors observed also that optical reflection values, such as lightness (*L**), changed during chopping and that *L** was correlated with *T*, *CL* and gel firmness, although they did not study the separate effect of processing factors, such as starch and fat levels on the observed correlations. Alvarez et al. (2007) suggested that allowing emulsion overheating during chopping would contribute to confirm that the beginning of a steady decrease in *L** during chopping is an accurate indicator of the optimum level of emulsification, while little information is available on optical changes in a wide range of temperature. Therefore, the aim of this work was to study the practical value of reflection photometry and *T* measured during emulsification as potential indicators of *CL* and texture in frankfurters within a wide range of emulsion temperatures, and starch and fat concentrations.

Materials and Methods

A randomized, factorial design with two factors and three replications was used. Pork batters were emulsified to obtain 4 different formulas by combining two fat (40, 20%) and starch (1, 4%) levels. Meat chopping was performed under processing conditions selected to ensure emulsion overheating (4 to 50ºC). Emulsion samples were obtained at 2 min from the beginning of chopping and every two min thereafter up to 16 min. *T*, pH and CIELAB color coordinates of the raw emulsion, as well as *CL* and texture profile analysis (*TPA*) of the cooked samples, were measured. Pork lean and backfat, ice (15%), salt (2.5%) and standard frankfurter additives (4%, Juan Martínez Pérez S.L.) were used for emulsion manufacturing. Pre-grounded, frozen meats (-18°C) were thawed at 4ºC up to 0ºC, mixed and chopped at 1.500 rpm in a silent cutter (Robot Coupe Chopper, R 5 V.V.). Raw samples at each chopping time were used to measure *T* (Crison TM 65 thermometer), pH (Crison pHmeter 2001) and CIELAB color values (Minolta chromameter II CR-200) while aliquots of each sample were stuffed into plastic screw tap cylindrical tubes (100 mL), heated at 75°C for 30 min and cooled at 4°C for 24 h, before textural and *CL* measurements were performed. *CL* was calculated by mass balance. TPA (Brookfield CNS Farnell QTS-25) was performed at 25°C. Pearson correlations, non-linear regressions and ANOVA were performed using Statistix 8 (Analytical Software).

Results and Discussion

During the emulsification process, *T* increased while L^* decreased. The initial increase of L^* described by Barbut (1998) and Álvarez et al. (2007) was not observed due to quick emulsification under the processing conditions used. *T* and color coordinates were strongly correlated with *CL* and *TPA* parameters (Table 1). The correlations of L^* with both *CL* and *TPA* were stronger than those of L^* with a^*, b^*. Cohesiveness (*Coh*) presented higher R with *T* and *L** than other *TPA* parameters. The ability of *T* and L^* to predict *CL* and *Coh* at different concentrations of fat and starch was evaluated. Non-linear regressions of both *CL* and *Coh* vs. L^* and *T* for each treatment are shown in Figure 1. The best R^2 were obtained using the following equations: $CL = b_1 e^{b_2 T}$ (Eq. 1); $CL = b_0 + b_1 L^{*b_2}$, (Eq. 2); $CL = b_0 + b_1 P + b_2 P^2 + b_3 P^3$, (Eq. 3), where β_0 to β_3 = regression coefficients and the predictor, *P*, in Eq. (3) represented either L^* or *T*. Slopes were more pronounced when *T*> 30ºC and L^*<70, respectively, i.e., at large chopping times (>7 min). Fat had a clearer effect on emulsion and gel properties than starch or fat-starch interaction (Table 2). Decreased fat and increased starch levels had similar effects as they decreased *T*, *L** and *CL* and increased *Hardness*. Reduced fat increased redness.

Conclusions

CL and textural parameters of frankfurters are significantly correlated with *T* and *L*a*b** values within the range of starch and fat levels used. Fat affected all optical and textural parameters studied as well as *CL*. Starch as well as the interaction fat-starch were found to be significant for L^*, *CL* and textural parameters. The results suggest that changes in color coordinates are potential indicators of the optimum chopping time, while changes in L^* during heating are potential for monitoring the gelification process during frankfurter manufacturing.

Table 1. Pearson´s correlations between emulsion and gel measurements in pork batters.

	CL	*Hardness*	*Gumminess*	*Springiness*	*Cohesiveness*	*Chewiness*
T	0.77***	-0.45***	-0.67***	-0.54***	-0.80***	-0.66***
*L**	-0.68***	0.44***	0.62***	0.42***	0.72***	0.61***
*a**	-0.53***	0.19**	0.40***	0.37***	0.58***	0.41***
*b**	-0.29***	0.22***	0.35***	0.21**	0.40***	0.35***
pH	-0.10	0.01	-0.07	0.03	-0.12	-0.05

Level of significance: *** P<0.001; **P<0.01; * P<0.05.

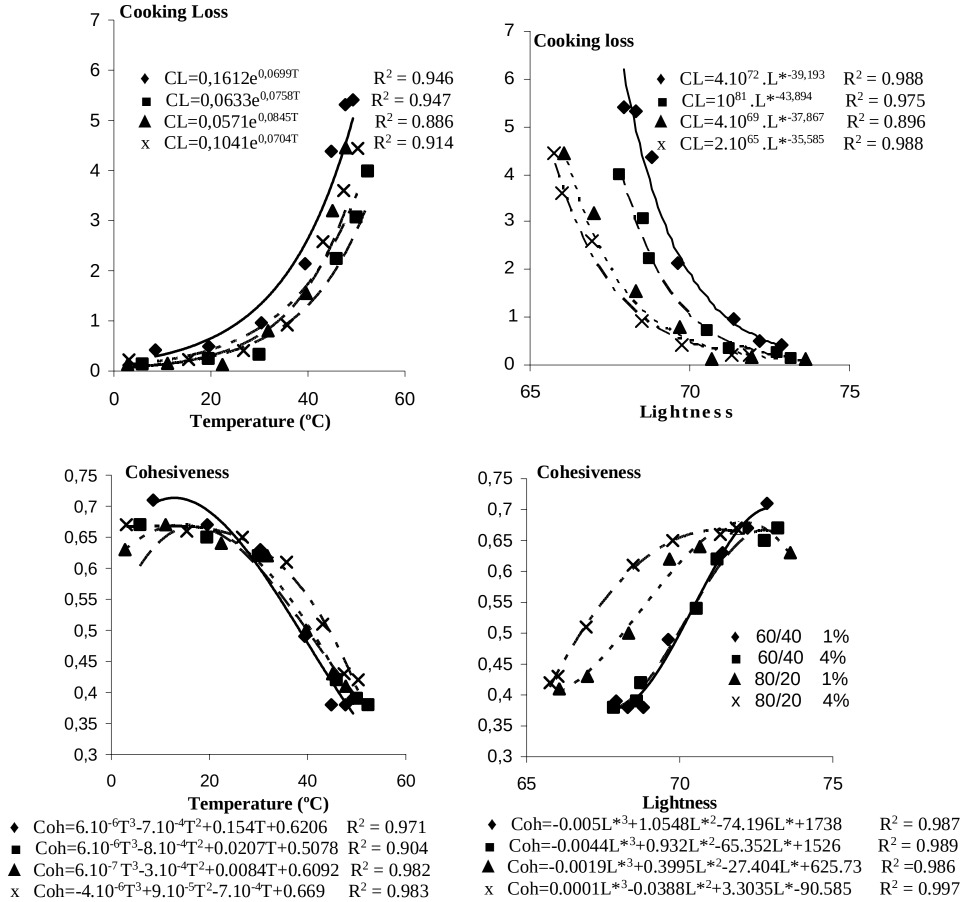

Figure 1. Predictive models for Cooking Loss/Cohesiveness *vs* Temperature/Lightness in pork batters.

Table 2. Influence of lean/fat ratio and starch percentage on physical properties of the batters.

N=240	Unit	*M* ± *SD*	Lean/Fat	Starch	Lean/Fat x Starch
Temperature	ºC	35.0 ± 9.64	***	*	*
*L**	CIE	69.7 ± 2.40	***	**	***
*a**	CIE	8.47 ± 1.18	***		
*b**	CIE	10.8 ± 0.80	***		
Cooking loss	% *w/w*	1.91 ± 1.96	***	***	***
Hardness	N	35.0 ± 9.64	**	*	***
Gumminess	N	19.7 ± 8.64	***	*	**
Springiness	mm	8.31 ± 0.44	***	*	***
Cohesiveness	Dimensionless	0.54 ± 0.13	***		
Chewiness	N m	165.8 ± 76.6	***	**	**

Co-variable: chopping time; Level of significance: *** P<0.001, **P<0.01, * P<0.05.

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