LIPID OXIDATION IN COOKED MEAT EMULSIONS. DEVELOPMENT OF A RESPONSE SURFACE MODEL.

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Background.

The cooked meat emulsion products are complex systems whose components are distributed in true solutions, in colloidal solutions, in suspension and in form of foam (Prändl, 1994).

The heat applied in the course of food processing produces many chemical reactions which are important in the production of flavour and off-flavour, and which could affect nutritional value and food safety (Lomano and Nawar,1982; Shantha and Decker, 1994; Aubourg, 1998).The response of a product to heat, according to Erickson (1998), is dependent on the end-point temperature and overall amount of heat applied .

Mielche and Bertelsen (1993) proposed a mathematical model to predict the development of Warmed off-flavour in minced beef during chill storage estimated increasing level of TBARS with increasing end-point temperature (60-80°C). Smith; Salih and Morgan, (1987), on the other hand, determined that acceleration in oxidation with increasing temperatures occurred only above a threshold temperature, which in the case of chicken breast was 74 °C. As temperature is further increased, another breakpoint develops in response to the generation of antioxidative Maillard reaction products.

Huang and Greene (1978) reported that beef under high temperatures and/or long periods of heating developed lower TBA numbers than did samples under lower temperatures for shorter periods of time during chill storage. According to Hamm (1966), the Maillard reactions in meat begins at about 90°C and increases with increased temperature and heating time.

The retardation in development of TBARS during chill storage at temperatures exceeding 100°C is believed to be due to production of antioxidative compounds in the Maillard reaction (MRP) (Mielche and Bertelsen, 1995).

Objective.

To contribute to elucidate the different effect of heating times on lipid oxidation in a model system of meat emulsion during storage at 15 °C (shelf temperature).

Methods.

50% of beef, 35 % pork, 15 % lard and 2% Cl Na were ground through 6 mm plates and emulsified in a colloidal mill (Cryma ®) . The meat emulsion prepared in coloidal mill, was moulded in patties of same weight (100 g), diameter (90 mm) and height (20 mm).They were divided into three batches , which were heated in static oven at 80 ° C for 4 , 7 and 10 hours; they were packed (RAPI-VAC S-750) in polyethylene bags with an oxygen transmission rate of 2000 cm^3 m^{-2} day^{-1}. All samples were stored at 15° C for 15 days. In each batch, analyses were carried out on the homogenized patties.

TBARS values were measured following the method of Jo and Ahn (1998). TBARS were expressed as moles of malonaldehyde per kilogram of dry matter to correct the differences in moisture loss by different heating time (Mielche and Bertelsen, 1993).

The lipids were extracted from the raw and cooked patties by a mixture of chloroform – methanol and water following the Bligh and Dyer method (1959); then they were evaporated to dryness in a rotary evaporator BÜCHI® R 114. Evaporation, facilitated by a stream of nitrogen, was carried out in a water bath at 50°C. The evaporated lipid was stored until analysis.

Peroxide values were measured by the AOCS official method (AOCS Cd 8-53,1993). Results were expressed as milliequivalents of peroxide per kilogram of sample. Duplicate peroxide measurement were performed on evaporated lipid.

The data obtained during storage were analyzed using Response surface methodology in Statgraphics Plus for Windows ® 4.0 software package. The experimental design adopted was multilevel factorial 3^2 , with one repetition, in which the two factors or independent selected variables were: Heating Time (T) and Storage Time (t), while the variable response were: Peroxide value (PV) and Thiobarbituric-acid-reactive substances (TBARS).

Results and discussion.

Peroxide values: The ANOVA of Peroxide values, used for comparison among treatments, showed that heating time as much as storage time , and the lineal interaction and quadratic heating time exerted significative effect in itself ($p<0,01$) .

The hydroperoxides development during storage increased in all heating and storage times. The rate of peroxide value formation was higher 8h of heating treatment, than 4h and 0 h respectively. Also we observed that the samples that developed higher PV at the end of 15 days, had a greater radical-free concentration at the begining of storage.

The regression equation and response surface (Fig 1) were (in decodified variables):

$$P.V. = -0{,}310584 + 1{,}79822 * T + 0.144957 * t - 0.20987 * T^2 + 0.120655 * T * t$$

Thiobarbituric-acid reactives substances: The ANOVA of TBARS values, used for comparison among treatments, showed that Heating time (T) as much as Storage time (t) and quadratic (TT) exerted significative effect in itself ($p<0,01$). The regresion equation and response surface (Fig 2) were (in decodified variables) :

$$TBARS = 6.92389 + 0.280019 * T + 0.289054 * t - 0.139189 * T^2$$

Conclusions.

The result presented in this paper could be indicated that during storage heating TBARS and PV increased, PV development was accelerated meanwhile TBARS was desacelerated, when heating time increased.

Although, the design experimental allowed to develop a predictive equation that relate TBARS and PV with different heating and storage time.

Pertinent Literature.

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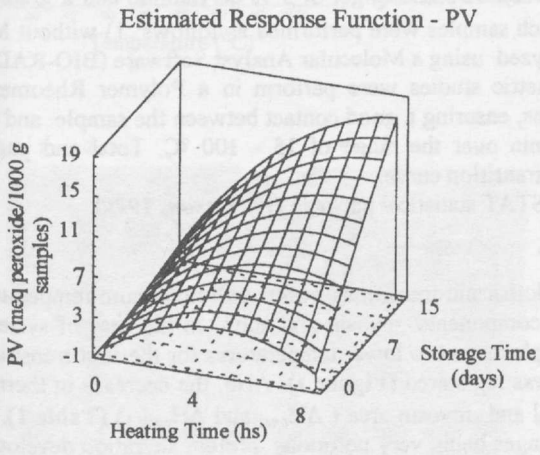

Fig.1 – Effects of heating and storage time on peroxide value (PV) in cooked meat emulsion

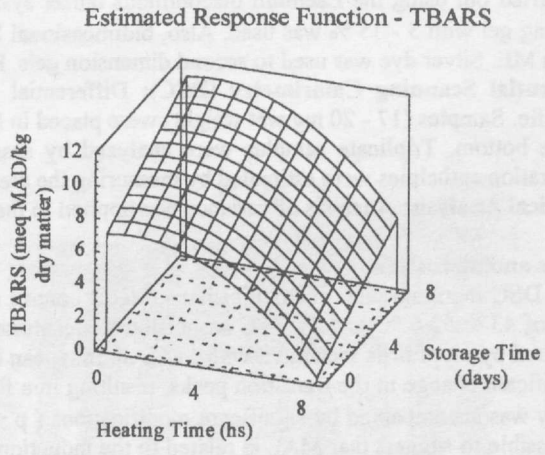

Fig.2 – Effects of heating and storage time on Thiobarbituric-acid-reactives substances (TBARS) in cooked meat emulsion.