RHEOLOGIC CHARACTERISTICS OF THE COMBINATION NATIVE STARCH-COMMERCIAL CARRAGEENIN IN WATER AND SALINE SOLUTIONS.

Magdalena Ramos, María Guerra, Roger de Hombre, Luis Chang and Ana Leyva.
Food Industry Research Institute, Ave. Rancho Boyeros km 3 1/2, Havana 13400, CUBA.

SUMMARY: The purpose of the present study was to assess rheologic properties (consistency) and water retention (as percentage loss) of meat paste gels in a model system. Accordingly, a factorial design 3^2 was carried out where factors evaluated were the following: type of additive and concentration. Levels used were the following: commercial carrageenin (0, 0.25 and 0.5 %) and potato starch (0, 5 and 10 %). Results show that carrageenin did not provide the textural and water-retention features required, while potato starch in the maximum dosages studied (10 %) provided sound consistency and reduced loss percentages (10 %), regardless of the carrageenin levels found.

INTRODUCTION: In order to decrease cooking losses and increase meat juices and added saline solution retention, different vegetable and animal proteins were used.

Other widely-used additives are the non proteinic gelifying agents, among which carrageenins are outstanding (de Hombre, 1986; Foegeding and Ramsey, 1986, 1987).

Basically, carrageenins are a collective technical term for a group of thickening and gelifying agents derived from red algae. They are non-proteinic polysaccharides, manufactured to obtain a specific function; they occur in a wide variety and differ in their application and properties (Pedersen, 1977: Graham, 1977: Anonymous, 1983).

Native starches are used with the same purposes. They influence definitely functional and organoleptic properties of meat products, a fact which is in turn dependent on their interactions with other components of the system under study (Rasmussen, 1972; Orovio et al., 1982; Descamps et al., 1986; Treadway, 1967).

The same is true of carrageenins, where the addition of sodium ions disrupts the gelifying power of these polysaccharides, resulting in fragile brittle gels (Pedersen, 1977).

The purpose of this study was to assess rheologic and water-retention properties of meat paste gels in a model system containing carrageenin and potato starch.

MATERIALS AND METHODS: In this study commercial carrageenin hydrogel FL-31 (Hispanoland, Inc.) was used. This is a purified extract of red algae (**Chondrus crispus** and **Furcellaria fustigata**) with addition of a small percentage of galactomananas to correct its characteristic properties, containing also potassium chloride as essential gelifying salt.

As starch potato starch of nutritional grade was used.

To evaluate the effectiveness of these two additives, a model system of meat paste at the laboratory scale was used. For this purpose a light brine formulation was developed containing 2,5 % sodium chloride, 0,3 % sodium tripolyphosphate and 0,05 % sodium nitrite. Dosis studied were the following: carrageenin 0, 0.25 and 0.5 %; and for potato starch 0.5 and 10 %.

Brine was prepared manually following this order: tripolyphosphate, sodium chloride, sodium nitrite, potato starch, and finally carrageenin. The solution was maintained at a temperature between 6 and 8 ºC throughout while the meat used was cut from hams of hogs killed at least 48 hours earlier. They had at most 10 % fat and were disk-ground at a size of 3 mm; they were then homogenized manually and kept in cooling conditions until reaching 5 ºC.

Once the meats were weighted and the brines prepared, according to the schedule prepared following the results of the factorial design 3^2 with replication of each treatment, these ingredients were packed in 1/4 kg tins (300 X 204.5). Weight was 221 g (91 g brine and 130 g meat). They were mixed manually, covered and stored at 2-4 ºC during 24 hours. Afterwards they were weighed and cooked in thermostatic water bath at 80 ºC, until the center of the product registered 72 ºC. Finnaly, the different variants wer cooled in cold water (2-6 ºC) and refrigerated (2-6 ºC) for 24 hours. After such a stretch of time, weights of drained fluids for each treatment were taken and losses calculated based on difference and expressed in percentages. Meanwhile the texture was each variant was measured instrumentally in an Instrom Universal Texturometer, model 1140 by means of penetretaion tests with a 16 mm diameter ball at a speed of 5 cm/min. From the figure obtained we estimated the "maximum penetration stregth", which was expressed in grams as a measure of the consistency of meat paste.

MATRIX OF THE EXPERIMENT: FACTORIAL DESIGN 3^2.

Treatment	% of carrageenin X_1	% of potato starch X_2
1	0	0
2	0.25	0
3	0.50	0
4	0	5
5	0.25	5
6	0.50	5
7	0	10
8	0.25	10
9	0.50	10

Loss percentage results and maximum penetration strength were entered in a customized program and the significant rates of the polynomy were estimated for $p<0.05$. The program was run on a IBM microcomputer. The pure error variance was calculated from the replications and the model adequacy was tested by Fisher´s test.

RESULTS AND DISCUSSION: Table 1 shows average results of percentage loss and maximum penetration strength for each treatment of the factorial design 3^2 used.

Values of significant rates for percentage losses were the following: $X_0 = 8.46$; $X_1 = -1.13$; $X_2 = -13.29$; $X^2 = 0.31$; $X^2 = 4.61$; $X_{12} = 0.52$ thsu making up the polynomy;
$y = 8.46 - 1.13\ X_1 - 13.29\ X_2 + 0.31\ X^2 + 4.61\ X^2 + 0.52\ X_{12}$
testing its fitness for $p<0.05$ according to Fisher´s test ($F_c = 478.5 > F_t = 2.30$).

From this polynomy it may be inferred that the greatest effect on losses was exerted by potato starch concentration in such a way that in order to minimize such losses an increase in this additive, within the levels of concentration studied was required (Table 1). Carrageenin, however, exerted a minimmum effect on such response variable y_1 (percentage loss) as well as the interaction between the two additives.

The high percentage of losses (Table 1), even when only carrageenin in its highest dosage was used (10.5 %), could be determined by the presence of soidum salts (Chloride, nitrite and tripolyphosphates) in the meat system. These sodiüm salts disrupt carrageenin gels, reducing their gelifying capacity and increasing syneresis, as reported in the literature (Rasmussen, 1967; Pedersen, 1977; Glicksman, 1983).

Figure 1 shows that the response surface was not linear, which fits the significance of the quadratic terms. A curve on its response surface is seen for potato starch and its most suitable value is close to the highest dosage used (9-10 %), while it response for carrageenin was almost linear, with no influence on its different dosis being seen.

For "maximum penetration strength" the significant rates were: $X_0 = 848.89$; $X_1 = 26.67$; $X_2 = 61.67$; $X^2 = -23.33$; $X^2 = 121.67$ and $X_{12} = 27.5$, thus making up the polynomy;
$y=848.89 + 26.67\ X_1 + 61.67\ X_2 - 23.33\ X^2 + 121.67\ X^2 + 27.5\ X_{12}$
testing its fitness for $p<0.05$, according to Fisher´s test ($F_c = 13.34 > 2.3$). Notably, the increase in starch dosages had a key effect ($X_2 = 61.67$) on the increased consistency of the mode system, much greater than that proved by carrageenin ($X_1 = 26.67$ and the interaction of both additives.

Table 1 shows that consistency values for treatments 1, 2 and 3 where only carrageenin was added showed somewhat higher values than samples 4, 5 and 6 where the mean dosage (5 %) of potato starch was also added. This may be explained by the higher water retention in the latter (lower losses).

Figure 2 shows the response suerface obtained from consistency, confirming the quadratic effect for both addtives. Outstanding is for carrageenin a sligh curve which attained its maximum consistency value in the mean level tested (0.25 %). For potato starch, however, the best consistency value was reached with the highest level used (10 %), confirming the non-linear behaviour of both additives.

CONCLUSIONS: Carrageenin in the leves used in this study did not provide the textural and water-retention properties desired, due to the effect induced by sodium salts that disrupted its gelifying capacity.

While the use of potato startch in its maximum dosage reduced percentage losses (0 %) and increased the consistency of the meat system, regardless of the carrageenin levels added.

REFERENCES:

-Anon (1983). Food Additives. Food Technology Review No. 58, Ed. Noyes. EE.UU.

-Hombre, R. de (1986) Reología y Textura de Alimentos. Conferencia IIIA. Ciudad de La Habana, Cuba.

-Descamps, O., Longevin, P., Combbs, D.H. (1986). Food Technology. April 81-85.

-Foegeding, E.A. and Ramsey, S.R. (1986). Journal of Food Science, 51 (1), 33-46.

-Foegeding, E.A. and Ramsey, S.R. (1987). Journal of Food Science 52(3), 549-553.

-Glicksman, M. (1983). Food Hydrocolloids. Vol. II C.R.C. Press EE.UU.

-Graham, H.D. (1977). Food Hydrocolloids 323-338.

-Orovio, L., Ramos, M., Guerra, M. and Delgado, G. (1982) Implantación de una Nueva Tecnología. Conferencia. Primer Encuentro de Especialistas de Carnes en Conservas. Cuba.

-Pedersen, J.K. (1977). Variation and characterization of gel texture produced by carrageenan. Part 1. Texture of water gels of kappa Carrageenan. 15th C.I.F.S.T. Meeting.

-Treadiway, R.H. (1967). Manufacture of potato starch. Chemistry and Technology de R. L. Whistter y E. F. Paschall. New York. Academic Press. Vol. II. 87-101.

Table 1. Results of the asessment of percentage loss and consistency of meat pastes for each of the treatments of the factorial design (3^2)

Treatments	Percentage losses (%) (Y_1)	Consistency (g) (Y_2)
1	27.82	890
2	26.17	930
3	25.72	860
4	11.13	780
5	8.30	830
6	6.45	890
7	0	970
8	0	1030
9	0	1050

Figure 1 Response surface plot of the effect of additives on losses (%)

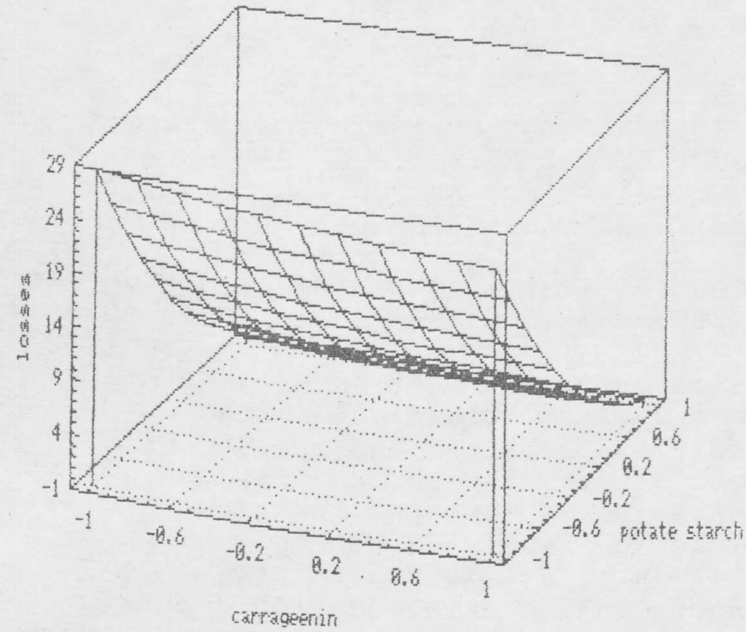

Figure 2 Response surface plot of the effect of additives on firmnes.