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RHEOLOGICAL AND STRUCTURAL OBSERVATIONS ON MEAT BATTER MANUFACTURED WITH COLLAGEN FIBERS

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BACKGROUND: Comminuted meat products frequently contain high content of connective tissue. The role of collagen in meat batters has been controversial (1). Because of high hidrophobicity (2) collagen molecules unfold during thermal processing and become possibly associated with lipophilic phase. In order to observe further the role of collagen during thermal treatment Bologna sausages with added beef collagen fibers were analysed for texture and stability. Moreover, histological slides from the product were stained with specific stain for collagen to study the changes within meat batter matrix.

OBJECTIVE: The aim of this work is to study by rheological and histological methods, the role of intact beef collagen fibers in Bologna sausages (Brazilian style) manufactured at various fat concentrations.

METHODS: Collagen fibers (CF) preparation - Intact CF was prepared from beef tendon aged between 4-5 yr old. Isolation of CF was carried out according to (3). **Brazilian style Bologna sausages preparation with added CF** - Raw materials were analysed for proximate chemical composition (Table 1). Brazilian style Bologna sausages formulation consisted of three fat levels of 18%, 24% and 30% with six CF levels of 0.0%, 0,40%, 0.8%, 1.2%, 1.6% and 2.0%. Meat ingredients (Table 2), water (12.5%), salt (2.2%), starch (2.0%), seasonings (1.0%), cure salt (0.3%), phosphate (0.2%) were finelly comminuted with Bowl cutter under vaccum. Meat batter was stuffed into 70 mm impermeable casings. Pieces were cooked in water bath at 70^{o}C until internal temp. reached the value of 66^{o}C. Samples were cooled down to 40^{o}C before storing at 5^{o}C. **Proximate analysis and pH, Stability, Firmness measurement, Fixation staining procedure -** Bologna sausages were analysed for moisture, protein, ash determinations according to (4). pH was determined directly in a pH meter. Meat batter stability was observed according to the technique described by (5). Bologna sausages firmness measurement was carried out according to the method described by (6). Bologna sausage samples were fixed in Boun liquid 24 hs before picro Sirius treatment as originally described (7, 8).

RESULTS & DISCUSSION - Proximate analysis - Collagen fibers (CF) - CF proximate composition is protein (78.8%), fat (9.2%), moisture (8.3%), ash (3.0) and hypro (8.13%). This hypro value is equivalent to 65.0% collagen (X 8.0; (9). Tables 1A, 1B, 1C show the proximate analysis of Bologna sausages containing 18%, 24% and 30% fat respectively. Different levels of CF were added accordingly in every Bologna sausages formulations. Fat and moisture decreased sligitly when CF was added whilst total protein concentration obviously increased its content due to gradual incorporation of CF. These results were obtained in every formulation. pH and ash content kept constant values throughout processing. **Meat batter stability** - Fig 1A shows different behaviour according to the gradual increase of fat content in the formulation. However with 30%, meat batter was less stable even with relatively high content of CF. These results showed that up to 24% fat, meat batter seemed to be stable even with high CF content. **Meat batter firmness** - Fig. 1B shows the gradual increase of Bologna sausage firmness concomitantly to the sequential incorporation of CF independently of fat content in the sausage formulation. Obviously higher the amount of fat more tender is the product and the texture would increase as more CF is added into the formulation. When comparing Figures 1 and 2, the amount of incorporated 1.2% CF seemed to be the best concentration of collagen for meat batter stabilization and texture under the processing conditions carried out in this work. This value represents aproximately 2% of total collagen within the product and 15-18% of collagen in relation to total protein content. These results are in agreement with the data reported by (1). **Microscopial studies** - Under the Bologna sausages processing conditions collagen gelatinizes. The changes of CF at microstructural level is shown in Figs 2A, 2B, 2C, 2D observed by light microscopy. In Fig 2A, the dark background is the unstained meat batter matrix and the location of muscle fibers proteins. Fat globules are uniformly observed while few endogenous collagen fibers are noticed as red colour stained with Picro-Sirius stain. Starch granules are seen as bright colour with a well marked cross. In Fig. 2B, meat batter section with 1.2% CF, Fat Globules (FG) are seem within the matrix. More stained CF are noticed and FG seem to keep their uniform shape. In Fig 2C, subtantial changes can be observed. FG lose their typical shape turning into spindle and non spherical shape. This fact indicates the presence of excessive quantity of connective tissue disrupts the matrix homogeneity (10). Meat batter disruption is probably caused by the shrinkage of the proteins matrix. The other factor could be when the amount of extractable protein is low collagen molecules will agregate decreasing the matrix integrity and the consequences is irregularity of its components shape as seen in Fig 2C. In Fig 2D, collagen fibers aggregate to form collagen islet (bright red color) turning the FG shape into spindle form. The zone without excessive CF, FG seem to have regular shape.

CONCLUSIONS: Bologna sausage firmness was higher at higher CF levels. Meat batter showed stability depending on fat level. Up to 24% fat level meat batter showed a linear stability with the gradual increase of CF. Microscopial studies reveal that at higher amounts of CF the meat batter is unstable. The instability seems to be due to shrinkage of muscle proteins and collagen aggregation with islets formation. **REFERENCES:**1)WHITTING,R.(1989).Rec. MeatConf.Proc.,42:149.2)BAILEY,A.J.&LIGHT, N.D.(1989).In:Connective Tissue in Meat and Meat Products. Elsevier, Barking, p.355. 3)EILERT, S.J. et al (1993). J.Food Sci,58:691. 4)AOAC, (1990). Methods of Analysis,Washington DC. 5)LIN, C.S. (1987). J.Food Sci., 52:267. 6)AREAS, J.A.& LAWRIE, R. (1984). Meat Sci, 11:275. 7)JUNQUEIRA, L.C.U. et al (1979). Histochem.J., 11:447. 8)FLINT, F.O. (1984). Analyst. 109:1505. 9)WOESSNER, J.F. (1961). Arch.Biochem.Biophys., 93:440. 10)KOOLMEES, P.A. et al (1993). Food Structure, 12:427.

Table 1. Proximate analysis of raw materials to manufacture Bologna sausages(%)

	Beef	Pork Jowl	Poultry MDM
Moisture	64.0	25.5	64.6
Protein	18.1	5.8	12.2
Fat	16.9	67.6	21.3

Table 2. Meat ingredients in each formulation

Ingredients(%)	Fat levels(%) 18	24	30
Beef	55.0	41.8	26.6
Pork Jowls	6.8	20.0	35.1
Poultry PMDM	20.0	20.0	20.0

Table 3A - Bologna sausage manufactured with 18% fat

\CF (%)	0.0	0.4	0.8	1.2	1.6	2.0
Moisture(%)	62.4	64.1	64.1	63.4	61.2	59.8
Fat(%)	18.3	17.2	14.5	16.1	16.7	15.2
Protein(%)	12.3	13.6	12.9	13.0	14.7	15.4
Ash(%)	4.0	4.0	4.0	4.0	4.0	3.9
Collagen**	1.2	1.5	1.8	2.0	2.3	2.5
pH	6.6	6.6	6.6	6.6	6.6	6.6

* Average of six samples analysis
** Hypro x 8.0 (10)

Table 3B - Bologna sausage manufactured with 24% fat

\CF(%)	0.0	0.4	0.8	1.2	1.6	2.0
Moisture(%)	56.5	55.4	57.8	54.9	54.8	54.8
Fat(%)	26.1	23.7	25.0	25.7	24.2	23.7
Protein(%)	12.5	12.8	13.5	11.7	12.2	13.1
Ash(%)	4.0	3.5	3.9	3.9	3.9	4.0
Collagen**	1.2	1.4	1.7	1.9	2.2	2.5
pH	6.6	6.6	6.6	6.6	6.6	6.6

* Average of six samples analysis
** Hypro x 8.0 (10)

Table 3C - Bologna sausage manufactured with 30% fat

\CF(*)	0.0	0.4	0.8	1.2	1.6	2.0
Moisture(%)	52.9	53.3	50.5	50.5	49.5	49.9
Fat(%)	32.1	32.4	30.9	29.5	30.3	30.4
Protein(%)	10.6	11.7	11.0	11.5	10.9	10.9
Ash(%)	3.8	3.8	3.8	3.8	3.7	3.7
Collagen**	1.2	1.5	1.8	2.0	2.3	2.5
pH	6.7	6.6	6.7	6.7	6.7	6.7

* Average of six samples analysis
** Hypro x 8.0 (10)

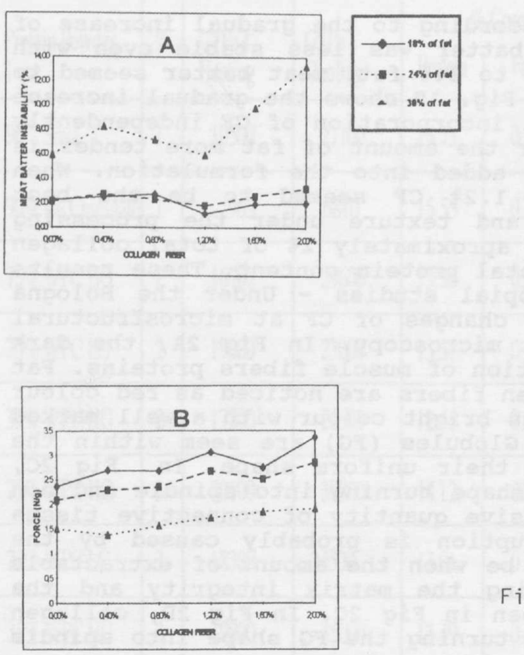

Fig. 1 - Fat and collagen fibers interaction on meat batter instability (A) and firmeness (B).

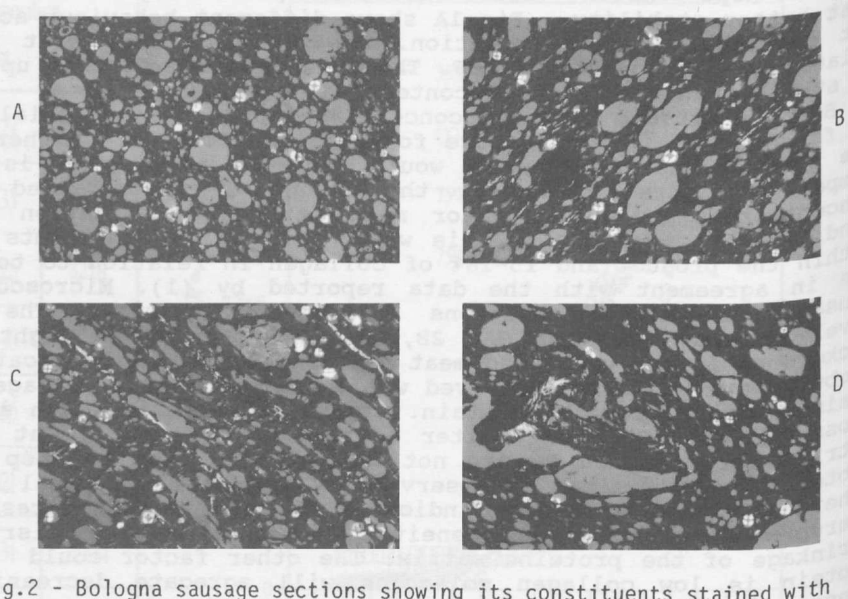

Fig.2 - Bologna sausage sections showing its constituents stained with picro-Sirius. A,B,C sections containing 0.0%, 1.2%, 2.0% respectively. B-CF distribution within meat batter matrix (dark zone) containing regular FG shape. C- Excessive CF (bright red color) FG-shape into spindle-shape. D- Section showing collagen islet formation and FG spindle-shape and a non excessive CF - zone shows regular FG shape.