HEME IRON FORTIFIED FOODS PRODUCTION

RAUL DIAZ, SERGIO FERNANDEZ, PEDRO REYES, MARIELA PARDO, MAGALY SEVARES, JUAN OCHOA and IRAN PRATTS.
UNIVERSITY of HAVANA, HAVANA 10400, CUBA

SUMMARY: Bovine blood cells were used in food formulae fortification. Meat products formulae containing 20-40 % pork meat, 6-10 %animal fat and 15-60 % blood cells, biscuit blends containing 5 % blood cells and sweets formulae containing 7-30 % blood cells were prepared. Heme iron content ranged 2.5-42.5 mg/100 g.
The fortified foods were accepted as ranked by judges and their shelf lifes were similar to that of the unfortified foods.

INTRODUCTION: Iron deficiency anemia is the most common nutritional deficiency in the world (Sweeten et al,1986).Iron fortification of foods is a common practice and inorganic iron has been widely used for this purpose, having the foods between 3 and 7 mg Fe/100 g (Lee and Greger,1983). In spite of the fact that blood cells are an excellent source of nutrients specially protein andiron, they are still greatly underutilized mainly because of the psichological barriers (Wismer-Pedersen, 1988). Whole blood has been used as source of iron in bread (Ranken,1977), milk and biscuits (Morales and Topp,1983) and milk and whey (Kiran et al,1986). The aim of this paper is to asses the way of using bovine blood cells in order to obtain heme iron fortified foods, having good sensory properties and appropiate shelf lifes.

MATERIALS AND METHODS: Bovine blood cells concentrate was obtained from a slaughterhouse in Havana City,Cuba, and were kept frozen (-20 °C) until its use.
Blood which was used in meat products was previously cured by adding 2.5 g ascorbic acid plus 0.5 g sodium nitrite to 1 L of blood cells 1-3 h before its use. For some products (morcellas, pudding, croquette, biscuit and swets),blood cells were precooked to a solid state. Production was done using the common technology for each one of them. Prepared sweets were:napoleons, tarts and rolls. Tarts and rolls were filled with fruit jellies and napoleons with stawberry flavoured whipped cream. Biscuits were filled or not with cream
Cold storage (2-4°C) was used when necessary.

-Meat products evaluation:

a) yield: cooking losses
b) chemical analysis: protein, fat, nitrite, moisture, ash, chloride, pH and iron (heme and total).
c) microbiological analysis: coliforms (faecal and total), coaugalase positive staphylococci and total counts of mesofilic aerobes and facultative anaerobes.
d) sensory evaluation: hedonic responses of untrained judges was measured using the following scale:
   1- "I would never eat it"
   7- "I woul ever eat it"
e) nutritional evaluation:pump calorimetry, Oser-Mitchell Index

(OMI) and biological value (BV) of protein were determined.

-Non meat products evaluation:

a) composition: iron
b) microbiological analysis: coliforms (faecal and total), coaugalase positive staphylococci and total counts of mesofilic aerobes and facultative anaerobes.
c) sensory evaluation: hedonic responses of untrained judges was measured using the following scale:
   1- "I dislike it extremly"
   7- "I like it extremly"

-Storage evaluation:

microbiological analysis and sensory evaluation were performed at appropiate time intervals.End point was defined by a lowering in the sensory score greater than one unit or by the expected shelf lifes values.

RESULTS AND DISCUSSION:

-Heme iron fortified meat products

Cooking losses (table 1) were similar to those obtained in our laboratory for unfortified meat products using dry air for cooking, but they are greater than the expected ones for an industrial processing. Chemical analysis (table 2) showed that the composition of the products resembled closely that of the non fortified meat products, only that protein, and specially iron (table 3), are greater. The iron levels are greater than others previously reported (Lee and Greger, 1983; Morales and Topp,1983) being a highly biodisposable one. If cooking losses could be reduced, iron levels would be also sligthly reduced too, but iron content would still be considerably high.

Table 1.- Average cooking losses for fortified meat products

Product	Cooking losses (a)
Frankfurter	22.7
Mortadella	12.8
Sausage "Colina"	30.5

(a) Mean of four replications

Table 2.- Average chemical values for fortified meat products.

Product	Chloride (%)	Moisture (%)	Nitrite ppm	Fat (%)	Protein (%)	Ash (%)	pH
Frankfurter	2.8	44.2	34.0	22.3	14.0	4.0	5.9
Mortadella	3.0	48.7	9.2	20.1	14.0	3.6	6.4
Sausage	4.4	50.9	32.7	12.3	18.1	5.2	5.6
Liver Product	2.6	48.2	4.4	27.1	17.0	3.4	6.1
Croquette	2.9	45.2	38.1	10.6	11.4	4.2	5.9
Morcella 1	1.9	51.6	-	36.5	15.8	6.0	7.0
Morcella 2	1.9	53.6	-	13.6	15.3	5.2	7.0
Morcella 3	2.0	43.6	-	36.0	11.0	2.7	7.0

Mean of eigth replications

Table 3.- Iron values for fortified meat products.

Product	Calculated values		Measured Iron
	Heme Iron	Total Iron	
Frankfurter	12.5	18.0	--
Mortadella	17.0	23.2	21.6
Sausage	17.0	23.2	21.3
Liver Product	19.0	22.0	--
Croquette	12.5	13.5	13.6
Morcella 1	51.5	61.6	--
Morcella 2	42.5	56.4	--
Morcella 3	42.5	56.4	--

Mean of eigth replications

Microbiological analysis showed the high sanitary quality of the products: coagulase-positive staphyloccoci and faecal coliforms were absent while counts of mesofilic aerobes and facultative anaerobes and coliforms were lower than 10^4 and 10 col/g respectively, at the end of the experiment.
Sensory analysis showed (table 4) that all products were

favourablely ranked by judges and that shelf-lifes were at least, as longer as expected.

Table 4.- Average values for hedonic response of fortified meat products

Product	Judges	Time			
		0	7	15	21
Frankfurter	90	5.92	6.05	5.66	5.00
Mortadella	90	5.80	5.93	5.48	4.87
Sausage	90	5.50	5.60	5.30	5.30
Liver Product	90	5.60	5.55	5.20	4.50
Croquette	90	5.90	5.92	5.60	4.90
Morcella 1	90	5.10	5.30	4.90	4.00
Morcella 2	90	5.20	5.20	4.96	4.01
Morcella 3	90	5.20	5.10	4.87	3.96

Nutritional evaluation (table 5) showed that the fortified meat products represents an important source of energy supplying a high quality mix of proteins.

Table 5.- Nutritional indexes for fortified meat products.

Product	OMI	BV	Energy (Kcal/100 g) (a)
Frankfurter	87.8	84.0	388.0
Mortadella	86.7	82.8	371.0
Sausage	87.7	84.9	319.0
Liver Product	90.9	87.4	342.0
Croquette	76.1	71.2	300.0
Morcella 1	80.7	76.2	505.0
Morcella 2	85.8	81.9	411.0
Morcella 3	80.1	75.7	479.0

(a) Mean of 3 replications

-Heme iron fortified non-meat products

Hedonic response (table 6) shows that people highly appreciate that kind of foods, being easier to mask the blood corpuscles addition. In spite of the fact that their iron's content (table 7) is lower than those of the fortified meat products, the non meat fortified products could represents an important source of highly biodisposable iron. They showed a high sanitary quality. Staphylococci and fecal coliforms were absents, moulds and yeasts were lower than 10 col/g and counts of mesophilic aerobes and facultative anaerobes were lower than 10^2 col/g except for pudding (lower than 10^3)

Both results, microbiological and sensorial, showed that the shelf-life of this products is similar to the expected one for

unriched foods.

Table 6.- Average values for hedonic responses for the non-meat fortified foods (90 untrained judges)

Product	Time (days)						
	1	2	7	15	21	30	45
Pudding	5.90	-	5.80	5.50	4.96	-	-
Biscuit (filled)	6.63	-	-	6.70	-	6.42	6.43
Biscuit	6.30	-	-	-	-	6.00	-
Tart	6.20	6.20	-	-	-	-	-
Napoleon	6.60	6.50	-	-	-	-	-
Rolls	6.30	6.50	-	-	-	-	-

Table 7.- Average iron values for thenon-meat fortified foods

Product	g/Unit	mg Fe/Unit	mg Fe/100 g
Pudding	-	-	34.3
Biscuit (filled)	-	-	4.7
Biscuit	-	-	6.5
Tarts	63	1.60	2.6
Napoleons	44	1.12	2.6
Rolls	81	1.80	2.3

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