OPTIMIZATION OF THE USE OF FOREIGN PROTEINS IN MORTADELLA (Bologna Sausage)

E. BIANCHI, A. CANTONI, F. LODI RIZZINI
Chair of Food Chemistry and Technology - Faculty of Sciences - university of Parma, Italy

The meat processing industry is increasingly interested in discovering new sources of animal and vegetable proteins. This is due not only to their economical advantages, but to their practical characteristics as well, the principal of those being as follows:
- fat emulsifying properties and stabilization of the resulting emulsions;
- gelatinizing capacity and consequential increase in water retention;
- cohesive characteristics which result in increased firmness of the meat mixtures;
- reduction in shrinkage during cooking and storage.

To date, those predominently considered have been isolated soybean proteins (Rakosky, 1970; Wolf, 1970), and caseinate (van den Hoven, 1987).
The aim of this study was to establish the optimum conditions for the utilisation of foreign proteins in a finely ground mixture similar to that of mortadella (Bologna sausage)(Ghinelli, 1975). Various studies have been documented about the effects of soybean (Baldini, Porretta, 1978; Pedrielli et al. 1979), caseinate and plasmatic proteins (Pedrielli et al. 1979), as well as powered skim milk (Rongey, Bratzler, 1966); these studies pointed out the negative influence that these proteins exerted on the colour, aroma and flavour as being the principal limitative factors in their use. In these studies singular proteins, sometimes in elevate dosages, were employed. In contrast, these studies evaluated the effects of their combined use. The following proteins were studied:
- isolated soybean proteins;
- sodium caseinate;
- powered pig skin.

These substances were introduced into medium-quality pork mortadella (Bologna sausage) mixture according to various procedures. After being stuffed and cooked, the mortadella were subjected to a sensory analysis evaluation by a panel of experts. The experimental program was conducted in three phases:
- projection of the utilisation of the proteins according to a statistical factorial plan;
- evaluation of the organoleptic characteristics of the finished product and calculation of a quality index;
- data formulation and evaluation of the optimum utilisation using the surface response method.

Type of proteins utilised

- SUPRO 535 isolated soybean proteins - Protein Technologies International - St. Louis (USA);
- EM 6 sodium caseinate - De Melkindustrie Veghel (NL);
- SCANPRO - 120 powered pig skin - Protein Foods Scandinavia A/S - Graasten (DK).

The composition of the original mixture was as follows:
- pork shoulder: 41-42%
- pork stomach: 15-16%
- throat lardon: 26-27%
- pork throat: 2-3%

The initial quantities of meat mixture were divided into 200 kg portions per test, comprised of 147 kg lean mixture (devoid of lardon and aromatic-salt blends) and 53 kg of lardon.
The following substances were added to this 200 kg initial mixture(in sufficient quantities to achieve the established dosages for each test):
- SUPRO 535 isolated soybean proteins; in powered;
- EM 6 sodium caseinate; fresh gel;
- SCANPRO 120 pig skin; fresh gel.

The quantities of proteins utilised in the finished mixtures are reported in Tab. 1.

Cooking shrinkage

After the mortadella was cooked and then left to cool at 10°C for 24 hours, it was weighed and the shrinkage percentage due to cooking was determined.

Consistency measurment

The consistency of the slices of several mortadella for each test was determined with a INSTRON mod.1140 texturometer.

Colour measurment

The colour of the slices of several mortadella from each test was measured with a GARDNER mod. XL 800 colourimeter revealing the Hunter parameters L, a, b, and a/b by measuring the reflection of three wave-lengths compared to a reference cushion pink XL 20 - 483 in which X= 58,3, Y= 50,0, Z= 49,1.

Examination of organoleptic characteristics

A panel of five expert testers evaluated several mortadella from each experiment, sliced after approx. 24 hours of storage at 10°C, according to the following criteria:
a) aspect of the sliced surface;
b) consistency evaluated as resistence to pressure;
c) internal colour;
d) aroma,
e) flavour.

Each expert expressed his evaluation on a scale of 1 to 10 as follows:
a) aspect of the sliced surface: 10= smooth, omogeneous; 6= irregular; 4= granular; 2= spotted (speckled);

O= wrinkled, spongy.
b) consistency: 10= firm; 8= tender; 4= moist (limp); 0= spongy.
c) internal colour: 10= pink; 8= light pink, 4= pale pink; 2= yellow pink; 0= dark pink.
d) aroma: 10= intense; 2= scarce; 0= nothing.
e) flavour: 10= good; 6= fairly; 4= scarce; 0= unpleasant.
These evaluations were expressed as aritmetical average based on the scores assigned and are reported in Tab.2.

Quality index calculation

In order to fine product quality, criteria was applied in which total quality index of a product (Ko) based on various individual quality characteristics (es. colour, taste, protein content, price, ecc.), that is Ko=f (K1, K2, ... Kn) where K1, K2, ... Kn are individual "n" parameters, qualitative and/or quantitative, of a product. Harrington's generic function of "desirability" was adopted, proposed by Ivashov et al.(1991) in reference to optimization of meat product formulation:

$$D = \sqrt[n]{d1 \times d2 \times dn}$$

where D is the total quality index and d1, d2, ... dn are decreased of diserability of individual parameters that represent physical/chemical, technical, sensory and economic measurements. In the case in point, these d-functions are represented by average scores in Tab. 2 purposely multiplied by fixed numerical coefficients. The quality index, thus obtained, are reported in Tab. 3.

Data elaboration

The formulations of the data was performed by utilising the statistical program "Statgraphics" of the Statistical Graphics Corporation - USA.
Using the data from Tab. 1 and 3 the relationship between levels of foreign proteins in the finished product (independent variables) and the quality index "Z" (dependent variable) was determined with the surface response method (Giovanni, 1983). Three surface that describe the regression of the dependent variable (quality index) on the indipendent variables (proteins) taken two-by-two were calculated. These surfaces extend from three coordinates: the two independent variables are located on the same horizonatl plane on the X and Y axes; whereas, the coordinate Z, which represents the dependent variable, is outlined perpendicolary in respect to the plane. In a two-dimentional representation, these lines define the areas in which any two points (X, Y) can be determined. Namely, the dosages of the combined proteins that satisfy the value of a selected Z index.

DISCUSSION OF THE RESULTS

The isoresponse diagrams obtained permit the following:
1) the prediction of the mortadella quality index based on pre-determimed levels of protein use;
2) the identification of the areas and corresponding ranges for which the utilisation of a combination of two proteins will satisfy a pre-determined quality index.

The surfaces of response for the pairs of experimented proteins are represented in Fig.1, 2 and 3. In Fig.4,5, and 6, the two-dimentional diagrams of the isoresponse lines are reported.
If isolated soybean protein and caseinate are utilised simultaneously (see Fig. 4), it is possible to observe how they are self-limiting in that, to achieve an acceptable level of quality (value of 45), there use is limited to quantities having no technological significance.
A value of 45 was adopted as the level of acceptability because it was veried that the sample mixture (prior to the addition of foreign proteins) registered a value of 50, whereas, the tests that achieve the best results appeared in a group that presented a minimum level of 45 (see Fig.7).
However, when the soybean protein is used together with the pig skin (see Fig.5), the use of the former can increase to 0,9% and that of the latter to 1,4%. The diagram in Fig.6, which represents the use of caseinate and pig skin, the possibility of pig skin use shows, at a quality index of 45, almost identical, whereas, the caseinate can reach 1,1%. The powdered pig skin emerges as the ingredient that has the least influence on the total quality index, only affecting the final result, as can be expected, by softening the meat and creating an improved mastication, always remaining within the tried percentages. It is important to remember that when these limits are exceeded. pig skin may form gelatin pouches, especially on the peripheral part of the casings. Evidently the action of the other proteins tested, soybean and caseinate, avoid this phenomenon. It follows that, to achieve the best result in the pleasing characteristics of mortadella, it is appropriate to combine the pig skin protein with the use of one of the two technologically functional proteins, soybean or caseinate. This may also permit the substitution of a portion of the fat normally added to the meat mixture to attain the desired softness and create a "leaner" product with the same characteristics.

CONCLUSIONS

The utilisation of foreign proteins in traditional meat preparations such as mortadella is subordinate to the preservation organoleptic qualities that the product claims and the comsumer demands. The results obtained allow the affermation that the utilisation of foreign proteins, of the type tested in this study, as secondary food ingredients in pure pork mortadella mixtures, can be considered optimum as long as the following instructions are compled with:
a) isolated soybean protein and caseinate, when utilised simultaneously, undergo a strong and reciprocal limitation, and therefore, their combined use produces unsatisfactory effects,given the extremely low dosage and lack of any practical influence.
b) isolated soybean protein and caseinate, utilised separatly with powdered pig skin protein, undergo minor restrictions and can be advantageous, achieving the same quality index with a costant value of 1,4% for pig skin protein, of 1,1% for caseinate and of 0,9% for the isolated soybean proteins.
At these quantities, all of the proteins exibit their technological properties.

TABLE 1: PERCENTAGES OF PROTEINS IN FINISHED MIXTURES

Test n°(mixture)	ISP 500E (%)	ISP 535 (%)	CAS.EM6 (%)	COT.SC.120 (%)
1	0,51	0,47	0,51	0,46
2	1,31	0,42	0,46	1,26
3	0,46	1,27	0,46	1,26
4	1,31	1,27	0,46	0,41
5	0,46	0,42	1,31	1,26
6	1,31	0,42	1,31	0,41
7	0,46	1,27	1,31	0,41
8	1,19	1,15	1,19	1,14
9	0	1,65	0,86	0,82
10	0	0	0,96	0,91
11	0	0,82	1,69	0,82
12	0	0,82	0,86	1,65
13	0	0,87	0,9,1	0,87
14	0	1,5	1,53	1,5
15	0	0,87	0	0,87
16	0	0,87	0,87	0
17	0	0	0	0
18	0	1,65	0	0,82

TABLE 3: QUALITY INDEXES OF MORTADELLA

Test n°(mixture)	QUALITY INDEX
1	40,10
2	20,66
3	38,07
4	23,94
5	9,24
6	20,30
7	49,44
8	50,24
9	26,67
10	62,30
11	50,60
12	15,60
13	50,30
14	18,35
15	44,48
16	18,17
17	50,70
18	26,53

TABLE 2: ORGANOLEPTIC EVALUATION

Test n°(mixture)	ASPECT	CONSISTENCY	COLOR	AROMA	FLAVOUR
1	2,1	6,8	8,6	9,4	8,6
2	6,0	4,2	0,4	3,6	9,0
3	9,2	3,8	9,4	2,2	9,6
4	2,2	4,0	2,2	3,6	9,8
5	2,0	9,6	0,2	3,8	0,4
6	2,4	7,2	9,4	0,2	9,2
7	9,4	7,4	9,6	4,0	9,6
8	9,6	7,8	9,4	4,2	9,4
9	4,2	4,2	3,8	3,8	4,6
10	9,6	9,6	9,6	9,4	9,8
11	9,2	9,4	9,2	3,8	9,6
12	5,8	9,2	0,4	0,4	9,4
13	9,4	9,4	8,2	4,2	9,2
14	6,2	0,2	3,6	4,4	9,2
15	5,8	8,8	8,2	4,2	8,6
16	5,6	0,2	9,2	3,8	4,4
17	9,4	8,2	9,6	4,2	9,4
18	5,8	1,2	3,8	9,4	4,4

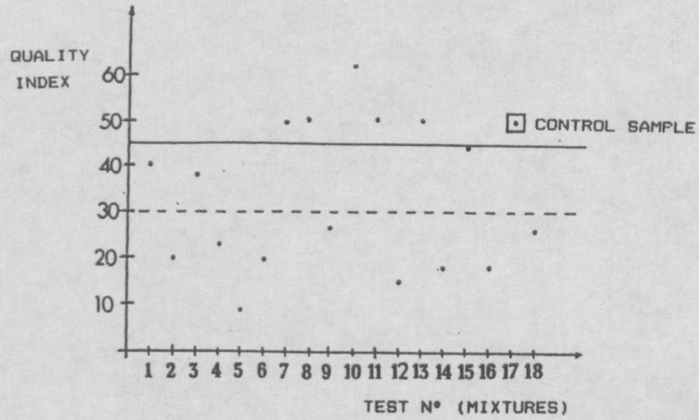

FIG..7 QUALITY INDEXES DISTRIBUTION

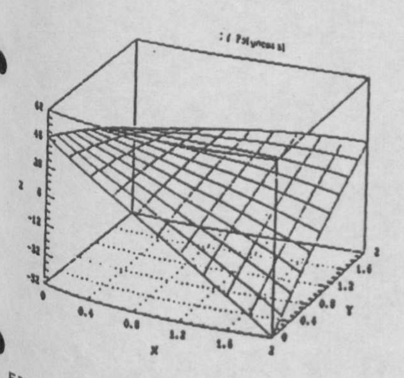

FIG.1: RESPONSE SURFACE FOR SUPRO 535/ CAS.EM6: Y=% of caseinate, X=% of Supro 535; Z= QUALITY INDEX.

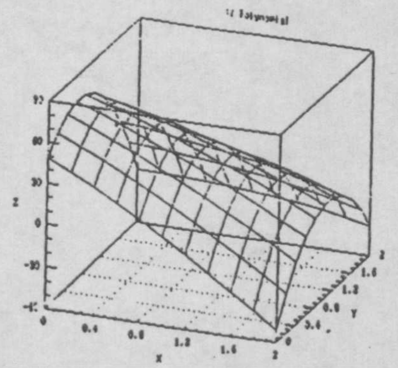

FIG.2: RESPONSE SURFACE FOR SUPRO 535/ SCANPRO 120: X=% of Su.535, Y=% of Sc.120; Z= QUALITY INDEX.

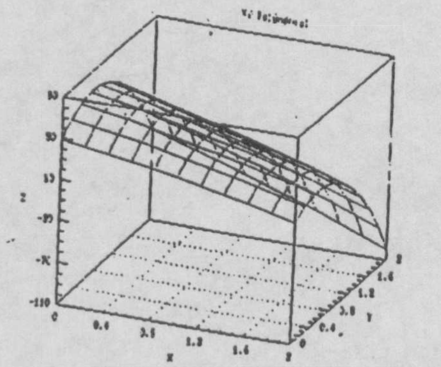

FIG.3: RESPONSE SURFACE FOR CAS. EM6/ SCANPRO 120: X=% of Cas.EM6,Y=% of Sc.120; Z= QUALITY INDEX.

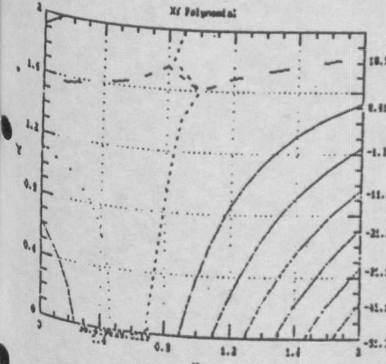

FIG.4: ISORESPONSE DIAGRAM: Y=% of Cas.EM6, X=% of SUPRO 535.

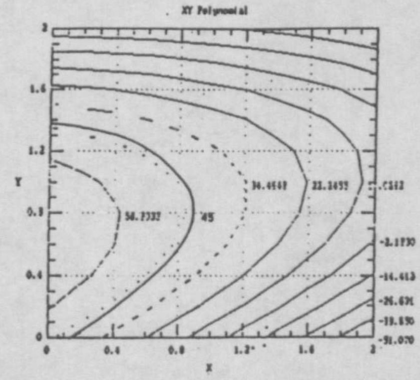

FIG.5: ISORESPONSE DIAGRAM: X=% of SUPRO 535, Y=% of SC.120.

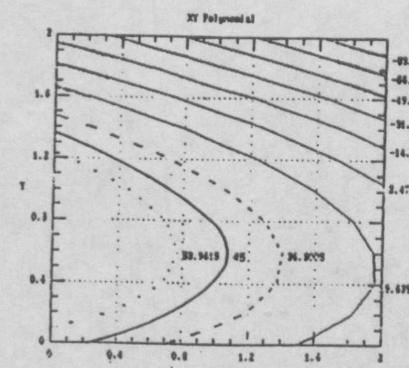

FIG.6: ISORESPONSE DIAGRAM: X=% of Cas.EM6, Y=% of SC.120.

REFERENCES

BALDINI P., PORRETTA A.: The use of soy proteins in the manifacture of some typical italian meat products: mortadella, salami, and fresh sausages. Industria Conserve (1978), 53, 267.

GHINELLI I.: Le carni conservate. Ed. La Nazionale, Parma (1975), 1842.

GIOVANNI M.: Response surface methodology and product optimization. Food Technology (1983), 37 (11), 41.

IVASHOV V.I. et al.: The use of complex quality criterion for optimization of meat products formulations. Proceedings of 37th ICMST, Kulmbach (Germany) 1991, 1055-1059.

PEDRIELLI R. et al.: Impiego di proteine alternative, animali e vegetali, in formulazioni per mortadella. Industria Conserve, (1979), 54, 204.

RAKOSKY J. Jr.: Soy products for the meat industry. J.Agr. Food Chem. (1970), 18, n.6, 1005.

RONGEY E.H., BRATZLER L.J.: The effects of various binders and meats on the palatability and processing characteristics of Bologna. Food Technology (1966), 20, (9), 134.

VAN DEN HOVEN M.: Functionality of dairy ingredients in meat products. Food Technology (1987), 41 (10), 72.

WOLF W.J.: Soybean proteins: their functional, chemical, and physical properties. J. Agr. Food Chem. (1970), 18, n.6, 969.