PREFORMULATION OF SAUSAGE RAW MATERIALS

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I. Introduction.

Preformulation can be defined as the concept of combining various materials and ingredients on a predetermined quality and quantity bases for the ultimate blending into sausage products. This concept appears to be relatively simple when only the essential steps are reviewed. However, when we consider in detail the factors and principles which are potentially involved in developing a preformulation system, we find a very complex problem. There has been a tremendous amount of research conducted on the basic physical and chemical properties of meat but their precise influence on the preformulation system is not well understood. Such factors as meat structure, proximate composition, protein solubility, type and nature of the fat, free moisture, water binding capacity, post-mortem age, product temperature and fat emulsifying capacity must be considered in light of their relative contribution to the system. Also, varying of the formula according to the cost of ingredients, meeting inspection requirements and determining the source of raw materials are important factors in developing a preblending system. Therefore, the simple placing of machinery in an orderly process, blending the mixture, determining the fat content and weighing the product into the chopper is an oversimplification of the ultimate goals of a preformulation system. Of course, recent developments in preformulation have resulted in major steps forward for the industry. The purpose of this presentation is to outline the principles and problems involved in the organization and development of an effective preformulation system for sausage products.

II. Classification and Standardization of Raw Materials.

The present system of classification for the preparation, sale and utilization of sausage meat materials has been used by the meat processing industry for many years. For example, we still operate on the basis of percent lean to fat in the preparation and sale of raw materials such as regular pork trim, beef chucks and 85% pork trimmings. In general, we have assumed that regardless of prior treatment or source of material that we have a sufficiently homogeneous meat mass, provided the lean to fat ratio is as specified by the trade. Recent studies have indicated that this is not sufficiently precise for good performance in sausage products (Saffle et al. 1964b; Borton et al. 1968; Townsend et al. 1968; Trautman, 1966). To compound this problem, we have a multitude of non-meat raw materials potentially available for consideration with meats in the preparation of comminuted meat products. Raw materials such as homogenized poultry and fish meat, soybean proteins, nonfat dry milk, egg proteins and cereal products are available to the processor. Each of these materials must be considered in the preparation of meat products. In most cases a detailed knowledge or method of evaluation of their functional properties and performance in the sausage is not available. This indicates the need for better methods of evaluation. In effect, the non-meat raw materials can be impinged upon the basic red meat formula. However, their inclusion must be considered at the time of developing a particular

system. For the purposes of this discussion, we will limit the discussion to that of red meat raw materials in a preformulation system.

It is evident that new developments will have to take place in the standardization and classification of raw materials in order to more precisely control product quality. We need only take a look at other industries involved in blending systems; such as ice cream, steel or textiles; to arrive at this conclusion.

III. Physical and Chemical Aspects of Meat Materials for Preformulation.

It is not possible in the limited time of this presentation to cover in detail the various physical and chemical properties of meat materials that must be considered in the proper formulation of meal emulsions. The literature is extensive on the study of the basic properties of meat raw materials and it is suffice to state that the challenge for the future is to apply these basic findings to the preformulation concept. Briefly, the major factors which need further application for efficiency in a preformulation system are: (a) the pH of the meat; (b) the state of rigor; (c) the length of storage of the meat at various temperatures including fresh and frozen state; (d) the amount of soluble protein and connective tissue; (e) the proximate analysis of the meat; (f) the fat melting point and chain length; (g) the application of additives to the premix.

At present, the meat processor is in a difficult position to classify, standardize and evaluate the above properties in the meat mass, with the exception of fat and moisture. In general, some very broad assumptions have to be made at this point in time. For example, it is generally assumed by the trade that the water binding and fat emulsification properties of the skeletal muscle tissue from pork are sufficiently uniform to meet the needs in sausage production, regardless of the source of the product or the condition of holding. Of course, exceptions do exist for factors such as frozen and pre-rigor meat but objective evaluation is not easy to accomplish. As we know, the conditions of freezing and storage vary tremendously and have a significant influence on the performance of the meat. However, these have not been clearly defined. I am sure that this example is sufficient to indicate the tremendous challenge for researchers in attempting to properly measure and classify the functional properties of the raw materials available to the industry.

There has been considerable work done on the post-mortem treatment of meats prior to use in sausages to overcome the inherent variation in chemical and physical properties and thus define and decrease the variation of the functional properties. For example, Turner et al. (1959) developed a system for the pre-rigor extraction of myosin by the use of salt. Also, recent work on the hot processing of pork would influence the development of a preformulation system (Mandigo et al. 1966). Many sausage processors are finding the necessity to increase the use of frozen meats. This presents another problem in developing a preformulation system. Thus, new concepts will require the adjustment in preformulation systems and in turn the preparation and distribution of raw materials to derive the maximum benefits.

IV. Preformulation Systems:

In recent years there has been considerable study and operational application of the preformulation of raw materials. If one studies the various systems presently in operation or those proposed by various workers, it is evident that a preformulation system must be developed on an individual plant basis. However, the basic principles employed in the system are similar for all operations. Kielsmeier et al. (1962) proposed a system for the preparation and compositional control of sausage materials. This system has been found to be practical and relatively efficient for the control of fat and moisture in the sausage formula. However, except for subjective evaluation, this system does not account for those physical and chemical factors mentioned previously in this paper, that ultimately influence the functional properties of the emulsion and the quality of the finished product.

In brief, a system such as proposed by Kielsmeier et al. (1962) would include the following essential steps for the control of fat, moisture and protein quantity:

A. The development of an approved formula for the quality standards desired.

B. The mixing of meats into a lean meat mass and a fat meat mass as prescribed in the approved formula.

C. Analyses of the two meat masses to determine the level of fat and moisture.

D. A proportional combination of the two masses to arrive at the desired fat and moisture levels of the formula.

E. Manufacture of the product and analysis of the finished product to determine if quality standards were obtained.

These steps are in effect an oversimplification of the program. The presently developed systems do accomplish improved control of fat, moisture and protein of the product. It is evident that this system is practical and is a major step forward for the industry, but there are many areas which require further investigation to obtain the ultimate goal in efficiency and quality control. The area requiring the most work at the present time is to obtain greater utilization efficiency and uniformity of the meat proteins. Also, it is evident that the quality and quantity of the fat and moisture have a profound influence on protein utilization. In addition, there is considerable need for the development of objective methods of evaluating factors such as emulsifying capacity, water binding capacity, color and flavor in the raw materials. These properties should ultimately be evaluated as objectively as we presently evaluate the fat level of the formula.

A preformulation system for raw materials should include the following principles:

A. Control of the source of raw materials. For example, the problems involved with handling of raw materials obtained within the plant are quite different from those purchased from outside sources.

B. Types and conditions of materials utilized in the formulation. Allowances must be made for differences between the condition of the meat at the time of preblending. The use of meats at the stage of pre-rigor, post-rigor, pre-salted, fresh or frozen and/or the various combinations of these conditions must be considered. Also the ratio of pork to beef, the use of additives such as soy protein, and the fat to moisture ratio will have a significant bearing on the system developed for the particular operation.

C. Statistical Evaluation. A preformulation system which is efficient and profitable for one processor does not mean that the same system will be efficient for another processor. Therefore, it is important that a detailed statistical analysis of the present system and the proposed preformulation system be made in view of the following:

(1) A proximate analysis of the raw materials under consideration for sufficient period of time to satisfactorily sample the population. (2) A determination of the most efficient types of equipment and materials handling system for the operation. (3) The time cycle for accomplishing maximum operational efficiency. (4) A determination of the microbiological factors involved. (5) Operation of a pilot system for a sufficient period of time to determine the variability. (6) An evaluation of the control gained by the proposed system. (7) An estimate of the potential value of any increase in the control of the quality in the finished product. (8) A detailed cost analysis of all factors in the present system as compared to the proposed system.

D. Alternate Systems. Consideration must be made for alternate systems which may be necessary to immediately initiate as standby measures in event of a change in operating circumstances. For example, a plant which is operating with a specified percentage of pre-rigor meats may find it necessary, when increased production volumes are required, that frozen meats be used in the preformulation system. Plans should be made prior to the initiation of the preformulation system to handle problems of this nature.

V. Systems of Analyses.

Since we have discussed the need for further work on methods of evaluating the efficiency and quality of the preformulation system, it seems in order to briefly state the present status of methods for evaluating the preformulation system. Briefly the methods which have the greatest bearing on the present systems are:

A. Protein analysis - the present method (A.O.A.C., 1965) is too slow to be of significant value in the preformulation system but can be used as a check on the finished product.

B. Fat analysis - The Paley method or modifications of this method using Babcock bottles is sufficiently accurate and rapid to accomplish a fat analysis of the preblended meat mass. This assumption is based on the analysis of a sufficient number of samples for each batch. This can be

accomplished by using standard statistical techniques. It is evident that the labor cost is a significant factor when this method is used. The Anyl-Ray system is perhaps the most rapid and practical method presently available for the analysis of fat level. However, salt cannot be present in the meats at the time of analysis. Also, it is relatively expensive and a fairly delicate instrument, thus requiring considerable maintenance. The methods using ether extraction are too slow for the preblended meat mass but may be used as a check on the finished product, (A.O.A.C., 1965).

C. Moisture analysis - The present methods available for the analysis of moisture in the meat mass are too slow or expensive to lend themselves to the high level of statistical sampling that is required. Systems such as the Brabender method of determining moisture are rapid but do not lend themselves to a high number of samples. The oven moisture determination (A.O.A.C., 1965) is time consuming and expensive but can be used to check on the finished product. The toluene method is satisfactory for some but too slow for many operations. The method proposed by Davis et al. (1966) is accurate and has potential value for some operations when time is not critical. The tables compiled by Maroney et al. (1959) for conversion of percent fat to percent moisture in raw meat materials are probably the most practical for moisture determinations in the preformulation system. Thus, a routine analysis for fat on each batch with selected sampling for protein and moisture analyses is perhaps the most practical approach.

D. The methods proposed by Saffle et al. (1964a and 1964b) for estimating soluble protein, emulsifying capacity and color are of value in formulating for computer and preformulation application. However, they are not practical for checking all batches in a fast moving operation. Nevertheless, these techniques are the best step forward that is available at the present and merit practical application.

E. Flavor analysis - So far as practical operating systems are concerned, the variation in flavor contribution by the various meat materials has not been considered to any great extent. Most operators who attempt to control flavor variations use different seasoning when the ratio of the meat species is wide. However, as a greater number of protein sources become available this will be a major area of concern. This has recently been exemplified in the work with various homogenized poultry and fish materials in comminuted products.

It is evident that methods of evaluation are sorely needed by the industry.

VI. Future Developments in Preformulation.

It would appear that the preblending and rapid fat analysis of the meat mass is a major step in the development of greater control in the manufacture of sausage products. However, much work is still needed to obtain maximum control and efficiency for all components which contribute to the performance of comminuted meat manufacture. The development of spun proteins and their use in making simulated meat products has brought focus upon the need for a greater degree of homogeneity in raw materials for comminuted products. It seems evident that as the demand for protein sources increases

throughout the world, a greater number of materials will be utilized in comminuted meats. Techniques such as the spinning of proteins will play a more important role. Thus, greater emphasis will be placed upon the fractionation and classification of meat carcass components. New systems will need to be developed for the classification and standardization of meats and it is foreseeable that these may be on the basis of characteristics such as the content of connective tissue, level of soluble protein, type of fat, contribution of color, contribution of flavor, etc. Thus it may be that the developments of the future will see meat materials sold on the basis of their relative contribution to the functional properties of comminuted product manufacture, rather than the present basis of carcass structure, origin of species, etc. Such treatments as presalting; hot processing; residual meat recovery from bones and trimmings; and the modification of protein and fat components are all possibilities for the future. It appears that the greatest challenge for the near future is the development of objective methods of evaluating the factors for their contribution to the functional properties. Ironically, probably the greatest motivating force for new developments is the extensive use of non-meat food materials in the preparation of comminuted meat products. We have already seen some of these developments emerge in the array of new spun protein products and the proposed use of homogenized poultry and fish materials.

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BOB CASSENS: Our next speaker is employed at the Eastern Utilization Research and Development Laboratories a division of USDA. He is responsible there for processing research to aid the development of improved and new methods of processing, handling, and storing meat and meat products, and of new meat products. He has done a considerable amount of work and has published in the area of his topic this morning; that is, the differential thermal analysis of fats in sausage formulation. Dr. Townsend.

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