Current Status of Mechanically Deboned Beef and Pork

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Mechanical deboning is a relatively simple process. Meat and bone are forced against a screened or slotted face plate. Meat and some marrow pass through the openings; the broken or coarsely ground bone does not. The bone may be salvaged for producing bone meal, animal feeds, fertilizer or for any of the other products bones are used for. The meat is acceptable for use in fresh ground meat, fresh sausage, and in a wide variety of processed meat items. While mechanically deboned poultry products are often used at levels of 50 to 100% in processed meat items, red meats are usually limited by industry to 10% of the finished product to avoid any changes in characteristics of the product. Current regulations for red meat limit the amount that can be used to 20% of the meat block (USDA, 1978). The regulations (USDA, 1978) do not allow mechanically deboned red meat (MDM) to be used in ground beef although it is well suited for this purpose.

Three types of mechanical deboners are commercially available: 1) the drum, 2) the rotating auger and 3) the press. According to Noble (1976), one drum type deboner forces meat and bone against microgrooves on a cylinder that will not allow particles of meat or bone larger than 0.001-0.010 mm to pass through. The drum type deboners were the first to be used. Some makes of drum boners were used 40 years ago to remove meat from fish bones in Japan. One of the early machines consists of a wide belt and a pulley. The pulley is a drum with holes drilled in it which turns. As fish or poultry bones drop onto the inner portion of the rotating belt, the bones are crushed against the drum by the belt and the meat attached to the bones is forced through the holes into the drum.

The rotating auger machines became popular about 20 years ago. The machines force red meat continuously through orifices approximately 0.46 mm in diameter but larger orifices are often used for fish and poultry. Some manufacturers are selling auger machines as multiple-purpose machines which can be used for deboning, desinewing and defatting. The machines desinew by removing connective tissue from lean and they defat by removing fat from pork skins. They have also been used to remove seeds from apples and pits from cherries.

The press machines are the most recent types of mechanical deboners to enter the market. These machines force whole or coarsely broken bone against a stationary slotted surface. One of the machines in this category uses rectangular slots 1.3 × 1 mm. As the batches of bone are pressed, meat and marrow is forced through the slots separating it from the bone.

The successful production of MDM throughout the world has encouraged the development of red meat deboners, and new patents for meat and bone separation are continually being granted. Neuhauser (1977) described a method used for further processing MDM with liquid to reduce bone powder. Gimel'fard and Zharinov (1977) described a rotating drum which tumbles bones with residual meat attached in water. After the meat is freed from the bone, water and fat are removed from the resulting meat emulsion with a centrifuge. Liquid separation of bone is also accomplished by coagulation of protein from alkaline extracts of beef bones by acidification, heating and freeze-thawing (Jelen et al., 1979; Golan and Jelen, 1979). Other reports on the technical feasibility of meat protein recovery from boning-room wastes by aqueous extracts are available (Duerr and Earle, 1974; Hamilton and Richert, 1976; Gorbatov et al., 1977).

This report will concentrate on the current status of MDM from machines which are being used commercially. Regulatory restrictions on its use in the U.S. will receive emphasis since the regulations are currently being revised. Potential yield, composition, nutritive value, palatability, functional properties, economic impact and safety will be covered only briefly or not at all in this paper. They are the subjects of a much more extensive review on MDM (Field, 1981).

First I want to make it clear that MDM is now approved for use in most major meat producing countries. Regulations governing MDM in the U.S. have been characterized by interim regulations, suits and withdrawals, proposals, hearings, and thousands of comments from consumers, industry and scientists. According to the USDA, a total of 4537 comments were received on its 1977 proposal (USDA, 1978). After reviewing all the comments, the information presented in public hearings, and the findings of government scientists, the USDA concluded that MDM is wholesome and safe and should be permitted, except in baby, junior, and toddler foods. The product was named "mechanically processed (species) product," and the regulations that were published in 1978 are in effect today. Several aspects of the regulations have been questioned.

Objectionable parts of the 1978 regulations include, the name, the labeling requirement, the minimum protein and maximum fat specifications, the 20% restriction on its use in meat products and the required analysis to ensure a minimum

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PER or essential amino acid content. This author also objects to exclusion of MDM from baby, junior and toddler foods.

Objections to the name "Mechanically Processed (Species) Product" arise because the name is not the common name and is different than the name the USDA continues to call chicken and turkey (USDA, 1979). "Mechanically Deboned Poultry" and "Mechanically Deboned Meat" are often produced by the same machines but the name "Mechanically Processed (Species) Product" must be used in the case of red meat, while the common name, "Mechanically Deboned Poultry" is the name used for poultry. The term "Mechanically Separated Meat" was adopted at the 10th session of the Codex Committee on Processed Meat and Products in Copenhagen, November 20-24, 1978, and is being used in some countries. "Mechanically recovered meat" is still another name that is used but by far the most common name is "Mechanically Deboned Meat."

The labeling requirement, which does not apply to poultry, is the major reason why very little MDM has been produced in the U.S. All labels of products containing MDM are required to qualify the product name with the phrase "With Mechanically Processed (Species) Product" in letters one-half the size of the product name. The additional qualifying statement "Contains Up to _____% Powdered Bone" must also appear in letters one quarter the size of the product name under the first qualifying statement. According to meat industry representatives the current labeling requirement is uninformative, confusing and derogatory and is the reason why millions of kgs of safe, nutritious meat is lost each year as human food. A petition by American Meat Institute and the Pacific Coast Meat Association states that "U.S. processors have invested more than $30,000,000 in deboning equipment and that most of it is not used" (National Provisioner, 1981). The petition also points out that current regulations cost consumers more than $500,000 a year because meat products, if they contained MDM, could be sold at a lower price.

The current regulations (USDA, 1978) limit MDM to 20% of the meat portion of the product in spite of the fact that MDM is higher in iron and calcium than is hand boned meat and these two minerals are the ones most often lacking in the diet. The addition of calcium to the diet via the small amount of bone powder in MDM must be considered a nutritional plus, since retention of calcium from bone sources is high (Forbes et al., 1921; Mitchell et al., 1937) and since many diets are low in calcium (Walker, 1972; Lutwak, 1975). The additional calcium intake would be particularly beneficial for persons who have osteoporosis and for those who receive long-term treatment with medications that induce a loss of calcium (Kolbye et al., 1977). In addition to calcium, iron is frequently inadequate in many diets (Food and Nutrition Board, 1980) and MDM contains two to three times as much iron as does hand boned meat (Field, 1981). Monsen et al. (1978) believe that the amount of absorbable iron must be based upon the amounts of heme and non-heme iron. Since hemoglobin from red marrow is found in MDM, meat containing MDM is not only high in iron content but it is high in iron that is more readily absorbed than is iron in many other foods.

The 20% limit for MDM in processed meat makes little sense if the intent is to limit certain nutrients in finished products which are found in MDM. Differences between MDM and hand boned meat are the result of bone marrow and bone powder in MDM and both of these ingredients are extremely variable in amount present. There is no limit on amount of bone marrow but bone powder is controlled by limiting calcium to 0.75% and MDM often ranges from 0.10% to 0.75% in calcium. Bones with more lean attached produce MDM with lower percentages of bone powder and marrow than do bones with less lean attached. In addition, some mechanical deboners are capable of producing MDM with very low levels of bone powder. Because the current regulations limit all MDM to 20% of the meat portion of the product, there is little incentive to produce MDM that is lower than 0.75% in calcium. Changing the regulation to limit the amount of calcium in the finished product in place of limiting the amount of MDM in the finished product would be the best way to limit calcium and it would allow for variable levels of MDM to be added. Requiring a nutrition label for all products containing MDM would be the best way of communicating to the customer the quality and quantity of nutrients in products containing MDM.

Mechanically deboned meat is obtained from carcasses of all different grades as well as from different anatomical parts that have been cut and trimmed by a variety of different methods. Therefore, it is not surprising that the composition of MDM varies by the same amount as the carcass parts from which it originates. Requirements of no less than 14% protein and no more than 30% fat are in effect for MDM. Mechanically deboned meat that fails to meet the protein or fat limits can still be used provided it is labeled "Imitation Mechanically Processed (Species) Product." Since lean and fat on approximately 50% of the items which could be mechanically deboned fail to meet the minimum protein and maximum fat requirements, the regulations discourage mechanical deboning and encourage continued hand trimming and continued waste of meat. Regulations already control the maximum fat content of finished products which could contain MDM. In addition, regulations on finished products have encouraged buying and selling of meat ingredients on a guaranteed maximum fat and minimum protein basis. Therefore, price encourages production of MDM with less fat because MDM with less fat is worth more per kg. Overall regulations on fat and protein content of a meat product ingredient, when there are already regulations on fat and protein in the finished product are costly and unnecessary.

Requirements for no less than a 2.5 PER or no less than 33% essential amino acids are met by almost all lots of MDM (Field, 1976). However, the analyses are expensive and time consuming and they are not needed. Questions regarding protein quality of MDM are based upon the false assumption that the collagen content in MDM is high. Since collagen content of bone is high (Brown et al., 1972), and since collagen is high in proline, glycine, and hydroxy proline, and low in many essential amino acids (Osborne et al., 1971; Eastoe et al., 1973) the assumption would be a logical one were it not for the fact that collagen is discarded by mechanical deboners with the bone (Field and Riley, 1974; Satterlee et al., 1971). Kolbye et al. (1977) found an average of 0.45% hydroxyproline in 30 samples of MDM. The figure is comparable to hydroxyproline figures for hand-boned meat of 0.57% for

beef shank, 0.36% for beef chuck and 0.37% for beef plate (Gillett et al., 1976). When the hydroxyproline level of 0.45% is multiplied by a factor of 7.25 (Eastoe and Leach, 1958) to convert hydroxyproline content to collagen content, the figure becomes 3.26% collagen in MDM. By way of comparison, Cross et al. (1978) found 3.35% collagen in minor cuts from Choice beef and 2.99% in triangles from Utility beef.

Even if collagen were higher in MDM, than it is in hand boned meat, there would be no need for the protein quality regulation. One protein expert has commented that he is not concerned about the collagen content of MDM because collagen is supplementary to other proteins and it increases the nutritional value overall (Kolbye et al., 1977). Protein quality regulations on MDM are not needed because: 1) MDM is high in protein quality, 2) MDM is used in conjunction with other meats which are high in protein quality and 3) consumption of enough high-quality protein in the United States is not a problem. The regulation on protein quality in MDM is not necessary from a health standpoint, and it is inflationary because of the added costs involved in determining amino acid content or PER values.

The exclusion of MDM from baby, junior and toddler foods in the present MDM regulations (USDA, 1978) is based on a concern that small amounts of fluoride added to infants' diets which are already high in fluoride could cause mottling of the teeth. A higher fluoride level would limit cavities; it could affect the appearance until the baby teeth were lost, but it would not affect their health (Kolbye et al., 1977). According to Labuza (1977), communities should fluoridate their water to help overcome deficiencies of fluoride in the diet. Those who oppose fluoridation of water (or meat) for political purposes are doing a disservice to the nutritional well being of their children since fluoride is an essential nutrient (Food and Nutrition Board, 1980), and mottling of infants' teeth is an unusual dietary occurrence. According to Knight and Winterfeldt (1977), beneficial intakes of fluoride could result from the use of MDM in areas where the intake might be low or where water is not fluoridated. This would include rural areas where additional nutrition from MDM is badly needed and where people with lower incomes normally buy lower-priced meat in which MDM would be included. Since the need to add fluoride to the water supply to prevent dental caries is well established, and since years of experience with mechanically deboned poultry in infant foods have not produced any documented cases of mottling of teeth, the exclusion of MDM in infant foods is open to question.

At the present time, new proposed regulations for MDM or, whatever the USDA is going to call it this time, are being prepared and it is hoped that errors in the 1978 regulations are being recognized. Mechanically deboned meat is a wholesome, nutritious, highly palatable product which can help overcome food shortages. New methods of recovering residual meat and marrow from bones are continually being developed. In the future more of these methods will be developed and more MDM will be produced if unnecessary government regulations are eliminated.

Discussion

D. M. Kinsman, Univ. of Conn.: I don't think you mentioned the zinc content. Is that not important.

Field: It has been an element that has been talked about by the nutritionists. Meat has been looked at with in favor in some eyes because of its zinc content. The analysis that the USDA did in 1977 in a number of labs found zinc content in MDM and hand boned meat quite similar.

Kinsman: We do have a national zinc deficiency.

Field: Yes, and meat helps there and MDM would help there as well.

Kauffman, Univ. of Wis.: Would you be willing to take us behind the scenes in USDA and tell us just what is going on concerning the regulation.

Field: I tell you, you think I know more than I think I know Bob. I think maybe you saw the statement by John Huston in one of the Provisioner's that said draft proposals responding to the petition of AMI and the Pacific Coast Meat Packers have been considered. The draft proposals for new regulations have gone forward to the Office of the General Counsel and the White House Office of Management and Budget. I think an advisory committee needs to be involved, but from my understanding, one has not been appointed yet. The people I talk to are very optimistic. They think changes will be made and the product will be allowed to compete on the same basis as chicken products. I agree very definitely with the former speaker for the increase in poultry products is due to the utilization of necks and backs and parts of the chicken that couldn't be otherwise utilized.

Question: Are there campaigns against the changes in this regulation that actually are creating this time lag in the change?

Field: You probably all realize that Carol Tucker Foreman was President of Community Nutrition Institute when the first campaign was started and later was named Asst. Secretary of Agriculture. I have heard a few people say maybe some of the people that have campaigned so heavily against MDM before have other things on their minds now and there won't be that kind of campaign. It remains to be seen once the proposals come out. I will say that practically all the ridiculous charges they trumped up before got newspaper headlines and these have been solved. Hopefully, they won't get headlines again.

B. Kelly, VPI: Is it possible that the variability in the protein and fat content of the product is causing some problems with processors making up their minds?

Field: Certainly they are going to have to buy it on the fat content just like they buy any other sausage ingredient. They're going to have to add some other specification with regard to how long it has been frozen and how it was chilled after it came out of the deboners. These are just common sense things they better plan to do with this and other products. I think since the poultry people have learned this they have made some very good products.

Allen, Univ. of Minn.: Ray, in that regard, is there in fact much mechanically deboned poultry meat that is traded in the industry out of the plant to another company.

Field: I'm going to defer to this gentlemen who just gave the talk on poultry as he knows more about the trade aspects than I do.

Cook, Louis Rich: We need some objectivity here. I think you should have pointed out the reasoning for powdered bone statement in the name for that particular product. In the Health and Safety report you eluded to, there was concern

about calcium and the high incidence of hyperabsorbers of calcium in the population. It was felt they should be made aware of this. One of the problems was trying to relate calcium absorbency in powder form, which is a poor choice of words.

Field: I'm not following you on calcium absorbency—of what?

Cook: Hyperabsorption of calcium.

Field: You're not saying that calcium is not readily available in powder form.

Cook: No, I'm not saying that, but more appropriately to the situation would be to go to partial calcium nutritional labeling rather than go to the statement X% calcium from powdered bone. There is such a negative connotation in that word. Another point should be made, the problem with the USDA was why they had to find another name other than meat because this report in Washington said this product was not meat, per se. However, Carol Tucker Foreman asked the industry to come up with an alternative name and the industry did not respond. I think this is the responsibility of the industry.

Field: Well I think there were a number of names given, Charlie. Including "mechanically separated product" which was accepted on a world basis.

Cook: Has the industry accepted that?

Field: With regard to your statement on calcium in the product, I'm personally very much in favor of nutritional labeling. I think there are some ingredients in this product that should be pointed out. There's certainly a very small portion of the population that is sensitive to the amount of iron. If we have a nutritional label on the product, the consumer would know exactly what they are getting and it would be much more sensible than limiting the product to 20% MDM or whatever.

Hargus, Campbell Soup: Is there any regulation as to particle size?

Field: There is in the current regulations. I don't know whether that will be changed or not. I don't hear a lot of people objecting to the current bone particle size statement in the current regulation. Whether or not that will be changed in the new proposal was strictly speculation on my part at least.

Huffman: Our contact person with CAST is Jim Kemp. CAST has requested that we get areas of concern to them we might like to have reviewed. If there are scientific issues here that should be studied by a task force it might be appropriate if we brought this to the attention of CAST by contacting Jim Kemp.

References

Brown, R. G., Aesbacker, H. U., and Funk, D. 1972. Connective tissue metabolism in swine IV: Growth dependent changes in the composition of long bones in female swine. Growth 36: 389.

Cross, H. R., Berry, B. W., Nichols, J. E., Elder, R. S., and Quick, J. A. 1978. Effect of desinewing versus grinding on textural properties of beef. J. Food Sci. 43: 1507.

Duerr, P. E. and Earle, M. D. 1974. The extraction of beef bones with water, dilute soldium hydroxide and dilute potassium chloride. J. Sci. Food Agric. 25: 121.

Eastoe, J. E., and Leach, A. A. 1958. A survey of recent work on the amino acid composition of vertebrate collagen and gelatin. *In* "Recent Advances in Gelatin and Glue Research" (G. Stainsby, ed.), p. 173, Pergamon, Oxford.

Eastoe, J. E., Martens, P., and Thomas, N. R. 1973. The amino acid composition of human hard tissue collagen in Osteogenesis imperfecta and Dentinagenesis imperfecta. Calcif. Tissue Res. 12: 91.

Field, R. A. 1976. Mechanically deboned red meat. Food Technol. 30(9): 38.

Field, R. A., and Riley, M. L. 1974. Characteristics of meat from mechanically deboned lamb breasts. J. Food Sci. 39: 851.

Field, R. A. 1981. Mechanically deboned red meat. Adv. Food Res. 27: 23.

Food and Nutrition Board, 1980. "Recommended Dietary Allowances." Natl. Acad. Sci., Washington, D.C.

Forbes, E. B., Halverson, J. O., Morgan, L. E. and Schulz, J. A. 1921. The metabolism of calcium compounds by growing swine-1. Ohio. Agric. Exp. Stn. Bull. 437.

Gillett, T. A., Tantikarnjathep, K., and Andrews, S. J. 1976. Mechanically desinewed meat: Its yield, composition and effect on palatability of cooked salami. J. Food Sci. 46: 766.

Gimel'fard, N. M. and Zharinov, V. I. 1977. Determination of nutritive value of meat obtained from final cleaning of bones; utilization of this method in sausage manufacture. Myasn. Ind. SSSR No. 4, p. 25.

Golan, A., and Jelen, P. 1979. Nutritional evaluation of low temperature alkaline extracts from beef bones. J. Food Sci. 44(2): 332.

Gorbatov, V. M., Barbetti, R. I., Bogatyrev, A. N., and Mizeretskii, N. N. 1977. Theoretical and experimental basis for the design of suitable equipment for meat deboning. Proc. Eur. Meet. Meat Res. Work., 23rd, 19 2:1.

Hamilton, R. G., and Richert, S. H. 1976. "New Possibilities for Recovery of Meat Protein from Soft and Hard Offal." Proc. Resour. Waste Manage. Semin. CSIRO, Sydney.

Jelen, P., Earle, M., and Edwardson, W. 1979. Recovery of meat protein from alkaline extracts of beef bones. J. Food Sci. 44(2): 327.

Knight, S., and Winterfeldt, E. A. 1977. Nutrient quality and acceptability of mechanically deboned meat. J. Am. Diet. Assoc. 71: 501.

Kolbye, A., Nelson, M. A., and Murphy, E. W. 1977. "Health and Safety Aspects of the Use of Mechanically Deboned Meat—Final Report and Recommendations Select Panel." Meat and Poultry Inspection Program, Food Safety and Quality Service, USDA, Washington, D.C.

Labuza, T. P. 1977. "Food and Your Well-Being." p. 138. West Publ. Co. New York.

Lutwak, L. 1975. The role of dietary calcium:Phosphorus ratio in human nutrition. Proc. Meat Ind. Res. Conf. p. 63.

Mitchell, H. H., Carol, W. E., Hamilton, T. S., Garrigus, W. P., and Hunt, G. E. 1937. Calcium and phosphorus supplements for growing swine. Ill. Agr. Exp. Stn. Bull. 434.

Monsen, E. R., Hallberg, L., Layrisse, M., Hegsted, D. M., Cook, J. D., Mertz, W., and Finch, C. A. 1978. Estimation of available dietary iron. Am. J. Clin. Nutr. 31: 134.

National Provisioner. 1981. Make It MDM. National Provisioner, 184(8):5.

Neuhäuser, S. 1977. A method of obtaining meat from bones by mechanical means. Fleischwirtschaft 57(10): 1754.

Noble, J. 1976. No bones about it—the case for mechanical deboning. Quick Frozen Foods 39(4): 185.

Osborne, R. M., Longton, R. W., and Lamberts, B. L. 1971. Rapid improved amino acid analysis of collagen. Anal. Biochem. 44: 317.

Satterlee, L. D., Froning, G. W., and Janky, D. M. 1971. Influence of skin content on composition of mechanically deboned poultry meat. J. Food Sci. 36: 979.

U.S.D.A. 1978. Mechanically processed (species) product: Standards and labeling requirements. Fed. Regist. 43: 26416.

U.S.D.A. 1979. Notice and Solicitation of Information: Mechanically Deboned Poultry, Fed. Regist. 44: 37965.

Walker, A. R. P. 1972. The human requirement of calcium: Should low intakes be supplemented? Am. J. Clin. Nutr. 24: 518.