

# Composition Studies on Meat and Bone Meal

## I. Proximate Analysis and the Calcium-Phosphorus Ratio

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### Summary

A proximate analysis of a variety of meat and bone meals has been made. A wide variation in the amounts of the various major components in meat and bone meal is due chiefly to a reciprocal relationship between ash and crude protein contents. The phosphorus and calcium of the ash are derived mainly from the bone and are present in the molar ratio of 1:15.

Meat and bone meals are plentiful, recurring, natural resources obtained as by-products of the domestic livestock industry. They are chiefly utilized by the feedstuff industry, and their applicability as industrial proteins has not been thoroughly investigated. These compositional studies have been initiated on a wide variety of meat and bone meals to determine their utilization potential.

Meat meals prepared from known types of animal by-products or by different processing conditions are rarely compared except by means of the proximate analysis which is one of the important specifications now required by feed manufacturers. The general acceptance of the proximate analysis by the feed industry has been responsible for the initial successes of feed formulation. But these studies can only be considered as preliminary evaluations of the meals since recent work on the nutritional availability of feedstuff has directed attention to the value of determining protein quality (1) and feed digestibility (2,3). Further progress can be expected as the work on the identification and determination of nutritionally important unidentified growth factors proceeds (4,5).

A proximate analysis was made on nine meat and bone meal samples as a basis to further studies on the composition of these products. The samples were provided by the National Renderers Assn. and represent products from the rendering of shop fat and bones, packing house offal, and head stock.

This proximate analysis includes determination of lipid (fat), moisture, crude protein, crude fiber, ash, iron, phosphorus and calcium. Specific AOAC methods for the analysis of meat and bone meal are lacking. The present AOAC methods for meat and meat products were adapted to the analysis of meat and bone meal. Also a rapid, titrimetric method using EDTA (10), was developed for the determination of calcium.

**Preparation of samples.** Commercial meat and bone meals contain small particles of bone suspended in finer particles of the proteinaceous material which segregate during blending. The values for moisture, fat and crude fiber were obtained by the analysis of this material directly using relatively large samples. To prepare a homogeneous sample for the laboratory analysis of crude protein, ash, iron, calcium and phosphorus, the meals were extracted with ether for 20 hours to remove the lipid fraction, air dried for 48 hours to remove the ether, ground in a Wiley mill to pass a 60 mesh sieve, and blended in a Patterson Kelley blender. This procedure resulted in a homogeneous free-flowing powder.

**Lipid determination.** A 200 g. sam-

**INTRODUCTION:** Some fundamental studies on the composition of meat and bone meal are described in the accompanying article. Nutritionists and other technicians in the feed industry will find the report of interest. The authors are on the staff of the Eastern Regional Research Laboratory, Eastern Utilization Research and Development Division, Agricultural Research Service, U.S. Department of Agriculture, at Philadelphia. Milton Lapidus and Lillian Lempka are research fellows of the National Renderers Assn. (NRA).

Miss Jamie Fox of the NRA points out that for the past two years, the association has sponsored basic research at the Eastern laboratory on meat and bone meal. Initial composition studies showed that the method of analysis of the AOAC would have to be adapted for analysis of meat and bone meal. "Studies at the laboratory," Miss Fox said, "will lead to improved methods for the analysis of meat and bone meal, aid in quality control and facilitate marketing of the product."

"An important consideration in this work will be whether the protein is available to the animal or bird in a digestible form, and for that reason the NRA feels that more attention should be paid to 'digestible protein.' The meat meal and meat and bone meal purchasing guides prepared by the AFMA Nutrition Council in cooperation with the NRA recognize this desirability by referring to 'minimum digestible protein.' There are fairly good laboratory procedures for determination of digestible protein, but it is felt that they require further refinement. The NRA, through its fellowship at the USDA laboratory, is cooperating in studies of protein digestibility and laboratory procedures.

"Going further into this question, NRA is doing considerable work in an effort to determine the amino acids present in animal protein and their availability and effect of raw material source and processing techniques on this availability.

"As part of a regular program of nutritional studies, NRA supports research at the American Meat Institute Foundation, State College of Washington, University of California, University of Delaware and North Carolina State College."

ple of the original meat and bone meal was placed in a 60x180 mm. Whatman thimble, covered with glass wool, and extracted for 20 hours in a Soxhlet apparatus with 250 ml. of ether. The ether extract and washings were transferred to a tared 250 ml. beaker and the ether evaporated on a steam bath. Evaporation was accelerated by directing a steady stream of compressed air on the solution. Water was removed by heating in a convection oven at 100° for 12 hours. The beaker containing the ether extractable material was cooled to room temperature in a desiccator, weighed, and the lipid content calculated from the increase in weight. This extracted material was used to prepare the sample for subsequent laboratory analysis.

**Moisture determination.** Oven dried pyrex weighing dishes fitted with ground glass covers were allowed to equilibrate with the temperature and humidity of the room before taring. Approximately 10 g. of the original sample or 2 g. of lipid extracted sample were weighed to 0.1 mg. in 30x75 mm. or 40x45 mm. tared weighing dishes, respectively. The samples were dried in a vacuum oven at 100° C. for 24 hours. Air, dried by passing successively through concentrated sulfuric acid and over anhydrous calcium chloride and anhydrous magnesium perchlorate, was passed slowly through the oven to sweep out moisture. This procedure was necessary to obtain constant weights on the original meat and bone meal since the presence of fat retarded moisture removal. After drying, the weighing dishes were closed and allowed to equilibrate with the temperature and humidity of the room before weighing. The moisture was calculated from the loss in weight.

**Ash determination.** A 2 g. sample of lipid extracted meat and bone meal was placed in a 60x50 mm. tared porcelain crucible. Five ml. of

60% (v/v) methanol-water solution containing 8 g. magnesium acetate per 100 ml. were added to the sample. The magnesium acetate prevented the loss of volatile anions (phosphates) and improved the reproducibility of the determination. The alcohol was burned off by touching the sample with an open flame, and the sample was dried overnight at 100° to remove moisture. The sample was placed in a cold muffle furnace and the temperature was raised to 600°. This temperature was maintained for four hours. The sample was removed from the muffle furnace after cooling to 200°, cooled in a desiccator, and weighed. A magnesium acetate blank was subtracted from the weight of ash to obtain the true sample ash.

**Crude protein determination.** The procedure and reagents were essentially those reported by Ogg and Willets (6). Approximately 60 mg. of a sample of lipid extracted meat and bone meal were weighed in a charging tube and transferred to a 30 ml. Kjeldahl digestion flask. The reagents were 1.9 g. of mercuric oxide-potassium sulfate mixture (1:50 by weight), 2 ml. of concentrated sulfuric acid, and a boiling chip. The sample was digested vigorously so that refluxing occurred in the neck of the flask and continued for 1 hour after clearing. After cooling, 5 ml. of distilled water were added to dissolve salts and the digest was transferred to a micro steam distillation apparatus. Then, 9.5 ml. of sodium hydroxide-sodium thiosulfate reagent (100 ml. of 16% sodium thiosulfate added to 400 ml. of saturated sodium hydroxide) were added to the still and 15 ml. of steam distillate were collected in 10 ml. of 4% boric acid solution containing 4 drops of methyl red-methylene blue indicator (2 volumes of 0.2% methyl red solution plus 1 volume 0.2% methylene blue solution, both in alcohol). The distillate was made up to 50 ml. and

titrated with .025 to a pink end standard nicotin. The factor 6.25 nitrogen to crud

Crude fiber (AOAC (7) meth crude fiber was nal meat and bo

Acid digest (mately 1 g. of a bone meal was (Kjeldahl flask v centrated nitric digestion rack ceased to be ev cooled, 10 ml. of were added, and tinued until hea peared and the The digest was ml. volumetric f volume with dis

Iron determin terminated in the of the o-phenan method of Fort One ml. of 10% drochloride and phenanthroline sample, the sta and a blank. Th justed to pH 3, and the absorba Beckman B s) 505 mμ.

The standard made by dissolv cal grade iron v centrated nitric one liter. Dilut were used to curve.

Phosphorus (phorus was det digest of meat means of the r Subbarow (9). standard, or bl ml. of acid mo g. of ammoniu grade dissolved water, added to water containi trated sulfuric adjusted to 1. swirled to mix ml. of reducin sodium bisulfite fite, and 0.1 g. 4-sulfonic acid water and the 100 ml.) was q tube swirled ag lution was stor and made up f sorbance of bla ard KH<sub>2</sub>PO<sub>4</sub> sol in calibrated t in a Beckman. after 30 minut

Calcium deto dium dihydrog traacetate dire conjunction wi was used to de acid digest of after removal of an Amberl form) ion exch

**Results**  
The oiliness size of each o: meat and bone adequate samp However, when greased and fir ed free flowing homogeneous a producible an tions performe experimental s tory agreement Because of the bined phosph amounts of me meat and bon tial to treat nesium ac so that re obtained. The pr commerc