A Method of Destroying Salmonella[1]

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Abstract

Salmonella in animal proteins or similar feed ingredients can be killed by putting the feedstuffs through a terminal heater whereby the materials in meal form are heated to a temperature of 99 C with a retention time of 2.5–3.0 min at that temperature, and with a moisture content of at least 10% in the materials entering the heater. Commercial heat exchangers are modified to serve as the terminal heaters. Partial cooling takes place as moisture flashes off on emergence from the heater or, if further cooling is desired, a smaller chilled heat exchanger may be attached to the equipment.

Many common feed ingredients, including the animal source proteins are heated during processing at temperatures high enough to kill salmonellae. Sanitary handling practices in the processing plants will do much to keep recontamination to a minimum but, in some cases, it has been very difficult to prevent occasional recontamination of the protein meals. For these plants, and for blenders, importers, or others whose products may be contaminated during shipment or storage, a method may be necessary for destroying salmonella. To be useful for this purpose, it must be effective in destroying salmonellae, it must not cause a reduction in nutritive value of the feeds, and it must be economical when we consider that it must be used on feeds or feed ingredients that may be priced at only 4 to 6 cents per pound.

Several different methods have been proposed for destroying salmonella in livestock feeds. Among them are: irradiation, chemical disinfection and heating.

Irradiation has been shown to be effective but costs preclude its use for animal feeds at the present time. It has been estimated that irradiation can be done for 0.5 cent per pound, but this would be 12% or more of the cost of some feed ingredients.

A gas sterilization method has been developed, which uses propylene oxide. This treatment is effective but, again, costs preclude its use for animal feeds. A question has also been raised regarding the possibility of chlorohydrin formation as a toxic end-product in treated feeds. That question has not yet been resolved although the system is being used in Europe, using ethylene oxide rather than propylene oxide.

The National Renderers Association and its research arm, the Fats and Proteins Research Foundation, felt that the simplest and probably the least costly method for destroying salmonella would be through the use of heat in a terminal heater through which the protein meals could pass as they leave the processing plant.

Preliminary laboratory work had indicated that a terminal heater could be effective. A pilot plant was then set up to gather more basic data on heat transfer rates, effectiveness in destroying salmonella, general operating conditions, and costs involved.

A disc-type heat exchanger was used. This type was selected because it was immediately available in a suitable size. Other types of heat exchangers should be equally effective if they provide enough heating surface.

In the early tests with this heat exchanger, meat and bone meal was used which had been artificially inoculated with *Salmonella senftenberg* (strain 8400, American Type Culture Collection) at a level of 250 MPN per gram. In later tests, naturally contaminated meals were also used.

It had been well established in previous work that the amount of heat required to destroy salmonella and other microorganisms in meat and bone meal was, within limits, inversely related to the amount of moisture present. Meat and bone meal normally contains from 4% to 8% moisture. Therefore, a steam or water injection device was used to add enough moisture at the input end of the heater to bring the moisture level up to at least 10%. Moisture in excess of about 10% sometimes caused the meal to agglomerate into soft lumps that passed through the heater without sufficient heating to the center of the lumps. Extra lugs were welded onto the disc tips to get better mixing, and to help break up lumps.

A long series of tests were run under varying conditions of temperature and moisture application. The results indicated that *Salmonella senftenberg* could be reduced to zero in every case where the artificially inoculated samples were used. In tests with naturally contaminated samples containing initially 2.3 to 4.3 MPN salmonella organisms per gram, they too, were reduced to zero under the following conditions: 9% to 10% moisture uniformly distributed in the feed; a balanced supply of 100 psig steam to the disc shafts and condensate trapping for each shaft; moisture vapor retained in the unit throughout the heating cycle by keeping the unit covered; a through-put rate of 21 to 26 lb per hr per square foot of heating surface; and a uniform material discharge temperature of 210 F.

With this particular piece of equipment, it was determined that the heat transfer rate from the rotating discs to the meal was 13 BTU/hr/ft^2/°F. Since that time larger commercial units have given values in the order of 19 BTU/hr/ft^2/°F. That means that in the larger units, a greater volume could be heated per hour per square foot of heating surface.

Other types of protein meals have also been tested in this equipment. As a result of these tests, we have made the following recommendations to destroy salmonella in protein materials: At least 10% of moisture in the feed material; a temperature of at least 210 F; and a residence time at that temperature of 2½ to 3 min.

The effects of this heating and moisturizing on the nutritive value of animal protein meals is not known at the present time. However, preliminary feeding tests using rats, have indicated that no significant changes take place due to the heating during this short time.

There is still the possibility of recontamination after the terminal heat treatment, particularly when the materials are handled in bulk as is the common practice.

It is not possible for a plant that may desire and need to use terminal heat treatment for salmonella control to initiate this procedure immediately. Selection of appropriate equipment takes time; the de-

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livery period on the equipment chosen may be a matter of months after placing an order; installation of the equipment and necessary on-site modifications cannot be accomplished overnight. Thus, purchasers of heating equipment and customers buying the final processed meals must not expect miracles in terms of the time that will elapse before terminally heated protein meal is available commercially in large volume.

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