PROTEIN AND FAT QUALITY OF SLUDGE AS A FEED CONSTITUENT.

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W-6B.22

SUMMARY

Many slaughterhouses perform their own water treatment nowadays. As a result of water treatment waste products of slaughter and meat processing are concentrated in sludge. Sludge consists mainly of organic material (protein and fat). Recently the application of sludge as a farmland fertilizer has been debated as a result of environmental problems. Provided the health of animals and humans is not adversely affected, sludge can be used as a feed constituent. To elucidate the protein and fat quality of flocculated sludge, raw sludge was collected at three broiler and four pig slaughterhouses. The mean protein and fat contents in dry matter of poultry sludge were 47% and 21%, respectively. In dry matter of pig sludge the mean protein and fat contents were 50% and 23%, respectively. The peroxide value in poultry and pig sludge was high (289 meq/kg fat; n=6), when $FeCl_3$ was used as a flocculant and was low (4 meq/kg fat; n=1) when calcium lignosulphonate was used. Mean percentage of TVN/Total N was 2.3% in poultry sludge and 5.2% in pig sludge. It was concluded that $FeCl_3$ as a flocculant has detrimental effects on fat quality. This together with the high Fe concentration will restrict the use of sludge as a feed constituent. Optimal preservation of protein may be achieved by Good Manufacturing Practices, i.e. reducing the time between water collection and water treatment. The enzymatic breakdown of protein and formation of volatile compounds could be minimized in this way. Calcium lignosulphonate as flocculant will lower fat oxidation (rancidity) in sludge, resulting in sludge that has a higher value as a feed constituent.

Introduction

The consumption of meat has increased during the last decennia. To meet the increasing consumers demand for cheap pig and poultry meat, slaughtering was intensified in a small number of slaughterhouses. During slaughter of animals and cleaning and disinfection, a lot of water is used. This process water is polluted with organic matter from animal origin, for instance from lairage, blood collection and evisceration. The costs for discharging this polluted water without treatment into a municipal sewerage have increased over the past years. Also the conditions for discharging water onto surface water have been restricted as a result of environmental rules. Therefore most slaughterhouses perform their own water pretreatment nowadays. Two different water treatment processes are in use to purify process water from slaughterhouses. The first one is a fysico-chemical method, i.e. flocculation-flotation. The second is a biological method in which aerobic activated sludge is used. Purified water and sludge are the resulting products from both water treatment methods. The dry matter in sludge mainly consists of protein and fat from animal origin. This means that sludge has potential for use as a feed constituent. Studies showed that flocculated slaughterhouse sludge has a chemical content that resembles soy bean meal and meat meal (Mulder et al, 1986). Activated slaughterhouse sludge resembled fish and soy bean meal (Vriens et al, 1989) or meat and bone meal (Heddle, 1979). As these meals are used as feed constituents, it was suggested that sludge can be used as an animal feed component too, provided that dispersion of both human and veterinary pathogenic micro-organisms is prevented. The results given in this paper are part of a study for the development of a method for upgrading slaughterhouse sludge for feeding purposes. Hereby the results of a study on protein and fat quality of flocculated and aerobic activated sludge from poultry and pig slaughterhouses are discussed.

Material and methods

Three broiler and four pig slaughterhouses were included in this survey. They were situated in Belgium and The Netherlands. In these slaughterhouses water was treated with (i) the flocculation-flotation method, (ii) with an aerobic activated sludge method or (iii) with a combination of elements from both these methods. Slaughterhouse with a flocculation-flotation water treatment process used $FeCl_3$ combined with polymeric solutions as flocculants, except for one slaughterhouse that used calcium lignosulphonate combined with sodium hexametaphosphate and sulphuric acid to obtain flocculation.
Depending on the water treatment process performed, fresh raw sludge was collected from the flotation unit or from the sedimentation basin. The pH in fresh sludge was measured. Sludge was kept at -20°C pending chemical analysis. The following analyses were performed by standard procedures: dry matter (NSI, 1973A), total free extractable fat (NSI, 1973B), free fatty acids (NSI, 1980A) and peroxide value (NSI, 1980B). Extraction of fats was performed with petroleum-ether (30-60°C)/methanol (2:1), filtration through glass fibre filter pads and vacuum distillation at 30-40°C for 15 minutes. Total nitrogen was analyzed according to Kjeldahl (NSI, 1975) and total volatile nitrogen (TVN) was also analyzed after precipitation with 10% trichloroacetic acid (TCA) according to Kjeldahl as described by Lindgren and Pleje (1983).

Results

In poultry sludge the mean protein content in dry matter was 47%. The mean fat content in dry matter from poultry sludge was 21%. In dry matter of pig sludge the mean protein and fat contents were 50% and 23%, respectively. When $FeCl_3$ was used as a flocculant, the peroxide value in poultry and pig sludge reached high values (289 meq/kg fat; n=6). At the slaughterhouse in which calcium lignosulphonate was used as flocculant, the peroxide value remained low (4 meq/kg fat; n=1). Mean percentage of TVN/Total N was 2.3% in poultry sludge and 5.2% in pig sludge.

Discussion

Compared to Mulder et al (1986), in this study flocculated poultry sludge contained less fat and more protein (47% versus 39% and 21% versus 34%, respectively). These differences were probably caused by the slaughter processes and water treatment processes applied. As most flocculants are non-specific in precipitation of protein, the amino acid content of sludge and process water will be comparable. This is in contrast with protein in activated sludge, which mainly consists of protein of microbial origin. A high peroxide value in fat from flocculated sludge, obtained with $FeCl_3$, can be explained by the catalytic action of Fe^{3+} on fat oxidation during water treatment (Black et al, 1992). Peroxide values increased when the water treatment process last longer. Oxidation of fat has a negative influence on the quality of sludge as a feed constituent by causing off-flavour and rancidity. When lignosulphonates are used as a flocculant in water treatment processes (Hopwood, 1980), the fat quality is preserved well. This is in accordance with others. This sludge is probably more suitable for feeding purposes (Hopwood and Rosen, 1972; Herstad and Hvidsten, 1973). As oxidation was low in this type of sludge, lignosulphonates seems to be a good alternative for $FeCl_3$. Another result of the application of $FeCl_3$ as a flocculant will be the increased concentration of iron in flocculated sludge, reducing the possibilities of using sludge as a feed constituent in high levels. As a result of microbial enzymatic activity in process water and sludge, breakdown of protein occurs during the time between collection and water treatment. Also in sludge the deterioration of protein goes on. Reduction of the storage time of both process water and sludge will probably result in a reduction of protein breakdown including amino acid breakdown. Thus resulting in low levels of volatile compounds such as ammonia.

Conclusions

$FeCl_3$ as a flocculant has detrimental effects on fat quality as a result of its catalytic action on fat oxidation. As a result of the high Fe concentration in sludge, the use of sludge as a feed constituent will be restricted to a certain level. To achieve optimal preservation of protein, Good Manufacturing Practices need to be applied. This means that the time between water collection, water treatment and sludge processing needs to be as short as possible. Then enzymatic breakdown of protein and formation of volatile compounds will be minimized. The use of calcium lignosulphonate as flocculant will result in a sludge with a lower fat oxidation (rancidity), compared to sludge produced with the aid of $FeCl_3$.

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