THE UTILIZATION OF STRUCTURAL MATERIAL FOR TREATMENT OF SLUDGE FROM FOOD INDUSTRY WASTEWATER

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Abstract: A study was carried out to utilize post-coagulation sludge generated during treatment of wastewater from slaughterhouse and fish processing wastewater. The post-coagulation sludge contains mainly water (from 75 - 96%) and organic components. The organic components cause putrefaction of this sludge, mainly due to protein presence. The post-coagulation sludge was mixed with structural materials (bentonite, chalk, peat, sawdust, paligorskit and glauconite) and left to dry at ambient air. The amount of dry matter, content of total Kjeldahl nitrogen and non-protein Kjeldahl nitrogen were determined along with time of storage. After a certain period of stabilization the mixed products can be further use for compost production

Keywords: post-coagulation sludge, slaughterhouse, fish processing, bentonite, chalk, sawdust, peat, glauconite, paligorskit

INTRODUCTION

During production of various types of food -products organic rich waste is generated, both solid and liquid. It usually consists of such main components as proteins and fat. The huge amount of organic pollutants in wastewater causes problems with its treatment. Such wastewater has direct influence on sewage collection system and municipal sewer system for example the pipe choking (Sroka et al. 2004). However, the worst influence is observed in work of the municipal wastewater treatment plant. The organic components of food industry wastewater cause putrefaction of sewage sludge, mainly due to protein presence and make the efficiency of activated sludge much worse (especially fat is responsible for this).

There are some methods of decreasing the negative effect of organic rich wastewater generated in food industry. One of this methods is to recover protein and fat during wastewater pretreatment and next to utilize the recovered substances (Aquilar et al. 2002).

In table 1 the concentration of particular pollutants in wastewater from fish processing and slaughterhouse are presented.

Table 1. Characteristics of wastewater from fish processing and slaughterhouse (Tomczak-Wandzel and Mędrzycka, 2006)

Parameter	Concentration range [mg/dm^3]	
	Fish processing wastewater	Slaugterhouse wastewater
BOD	4 250 – 9 900	2 850 – 7 600
COD	5 500 – 12 900	3 400 – 9 700
Protein	1 250 – 2 740	1 250 – 5 720
Fat	400 – 2 450	75 – 225
Suspended solids	450 – 2 650	1 150 – 2 450

As it can be seen from table 1 the main components of such wastewaters are proteins and fats, substances of nutritious value, and the load of these pollutants may be extremely high and variable. It is easily to foresee that if wastewater from meat and fish processing industry is discharged to municipal biological treatment plant, the losses of proteins and fats are huge and severe problems with treatment of such wastewater are very often. The possibility of the solving of these problems is to recover these components during wastewater pretreatment before biological process.

Wastewater from fish and meat processing sector can be pretreated mechanically and chemically (Bohdziewicz et al. 2002; Urbaniak and Sakson 1999, Kim 1995). Chemical treatment is a coagulation process in which the added chemicals (coagulants) form flocks to which dispersed pollutants can easily attach. This material is separated from wastewater by sedimentation. Usually such coagulants as aluminium and iron salts are used (Kim, 1995). Post-coagulation sediment from meat processing wastewater consists of coagulant and separated pollutants e.g. proteins, fats and other colloids and could be used for animal feed production, or utilized for compost production (Mędrzycka and Tomczak-Wandzel 2000). However, the main component of this sludge is water, what causes problems with its further utilization.

Mixing with structural material which absorbs water seems to be one of the optimal solutions. Thus, the aim of this research was to find the best structural material for mixing with post-coagulation sludge in order to obtain useful form for easy transport and e.g. compost production.

MATERIALS AND METHODS

The post-coagulation sludges were obtained from industrial pretreatment plants (Pomorskie Voivodship, Poland), in which wastewater from fish processing and slaughterhouse are treated (chemical coagulation with using $Fe_2(SO_4)_3$ solution). The characteristics of post-coagulation sludges is presented in table 2.

Table 2. Characteristics of post-coagulation sludges

Parameter	Value	
	Fish processing	Slaughterhouse
Water [%]	73.1 - 81.7	94.5 - 97.0
Protein [g/dm^3]	23.4 - 37.5	2.5 - 5.5
Fat [g/dm^3]	11.1 - 75.2	0.25 - 0.50

The structural materials used in our investigations were: peat, chalk, bentonite, sawdust (Polish sources), paligorskit and glauconite (Ukrainian sources). The sludge and structural materials were mixed in weight ratio depending on the amount of water which particular material was able to absorb (Table 3). Thus, the highest content of sawdust and the lowest of glauconite were applied. The weight ratio is presented in Table 3.

Table 3. Weight ratio in the mixtures of sludge and structural material

Structural material	Weight ratio sludge: structural material
Glauconite	1:1
Paligorskit	4:3
Bentonite	3:2
Sawdust	6:1
Peat	2:1
Chalk	2:1

Afterwards, the mixtures were stored in the open air at room temperature up to 21 days. The content of dry matter, total Kjeldahl nitrogen and non-protein Kjeldahl nitrogen were determined at the beginning and every three days. In Figs 1 and 2 the changes of dry matter in all mixtures during storage are presented.

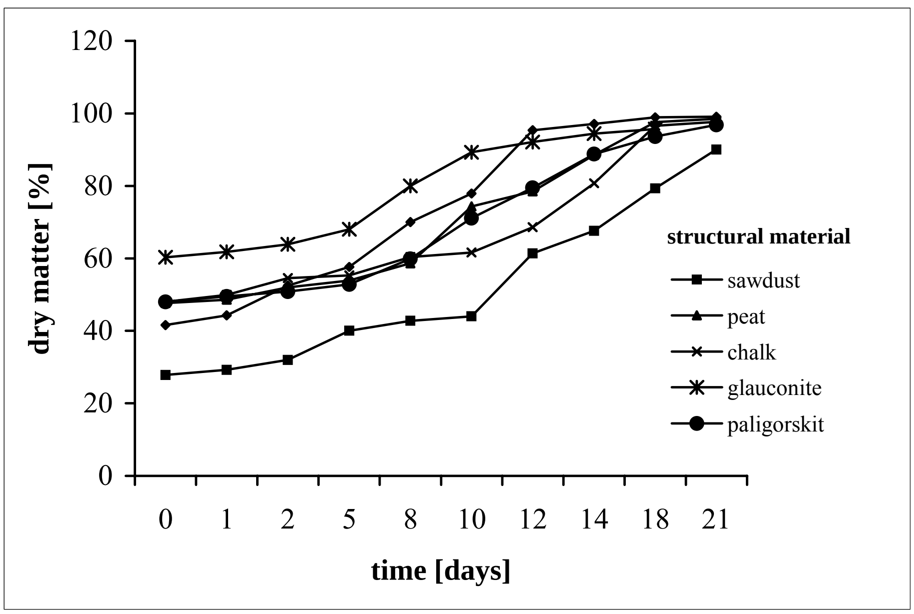

Figure 1. Changes of dry matter in the mixtures during storage; sludge from fish processing wastewater

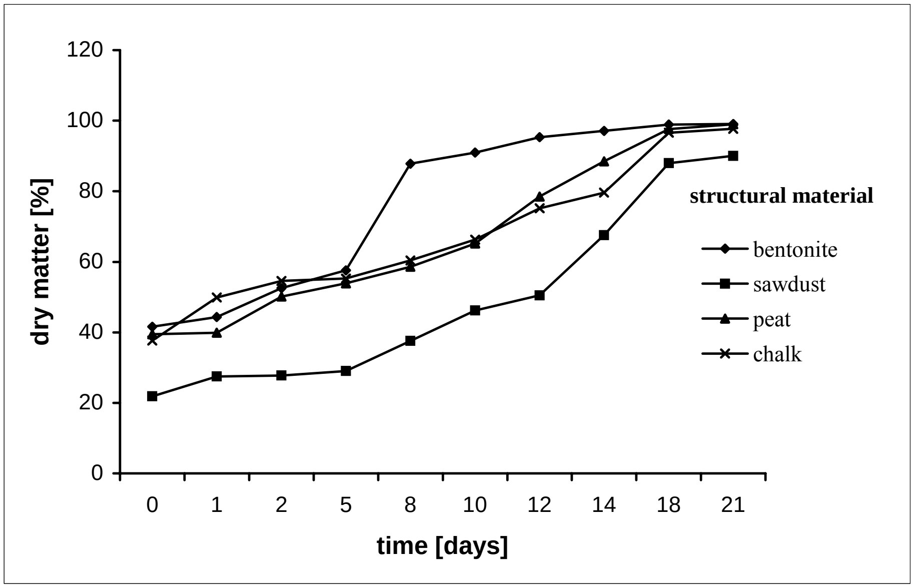

Figure 2. Changes of dry matter in the mixtures during storage; sludge from slaughterhouse wastewater

As it is visible, the decrease of water content during storage took place. For fish processing sludge (Fig.1), the highest initial content of dry matter was observed for the mixtures with glauconite (40% of water), and the lowest for sawdust (72% of water). After three weeks in all mixtures the humidity was found at similar level (about 96-98%), except of mixture with sawdust (90% of dry matter). For slaughterhouse sludge (Fig. 2) the best dewatering was observd for the mixture with bentonite (decrease from 60% to 2 % of water content). In the mixture with sawdust the water content at the beginning was higher (80%) due to higher sludge contribution and the final content of water was about 10 %.

Thus, it can be concluded that during storage period (three weeks) the humidity of the mixtures has decreased to a very low level, what makes the products safe from biological point of view and easy for transport. However, the product value depends on the content of nutritive components e.g. proteins, and this depends on the water absorption capacity of particular structure material.

In Figs 3 and 4 the content of total Kjeldahl nitrogen (TKN) in the mixtures are presented. This parameter is a measure of organic nitrogenous compounds content, mainly proteins. The initial total Kjeldahl nitrogen content depends on the mixture composition as well as on the properties of structural material (e.g. peat contains also organic nitrogenous compounds which contribute to TKN). The decrease of TKN content along with time is evident and this is a result mainly of water loss due to drying. However, decomposition of proteins during the storage is also possible.

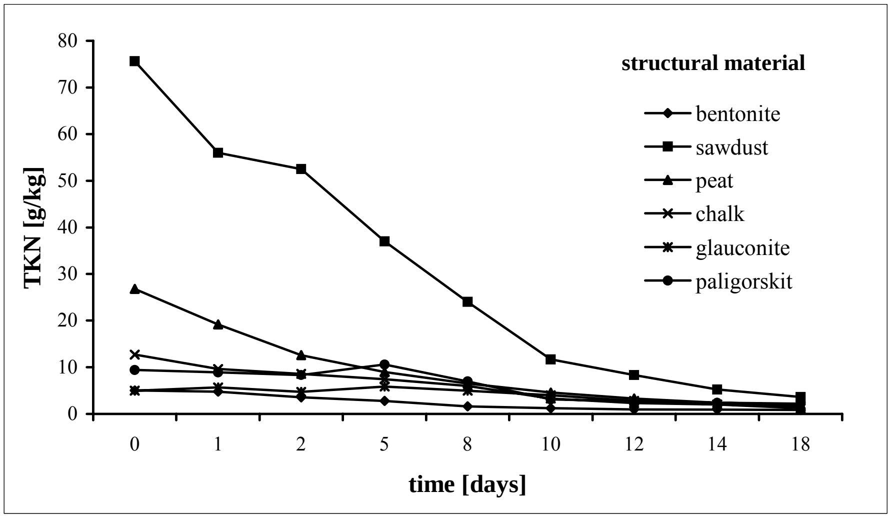

Figure 3. Changes of the total Kjeldahl nitrogen content in the mixtures during storage; sludge from fish processing wastewater

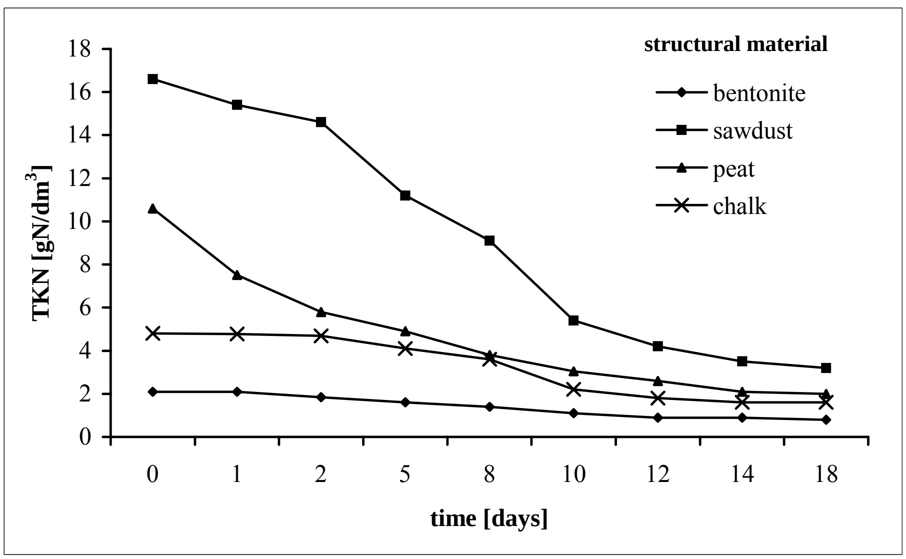

Figure 4. Changes of the total Kjeldahl nitrogen content in the mixture during storage; sludge from slaughterhouse wastewater

In Fig 5. the changes of Kjeldahl nitrogen during the storage of the mixtures with the sludge from slaughterhouse are presented. It is shown, that the content of organic nitrogenous compounds decreases within the investigation period (21 days), depending on structural material used, up to 50% (bentonite) to 85 % (peat).

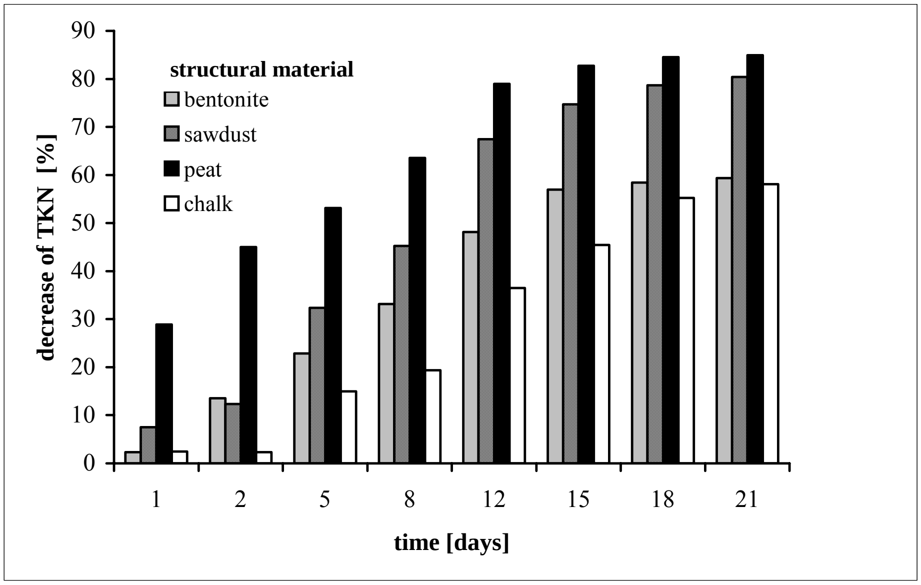

Figure 5. Decrease of the total Kjeldahl nitrogen content in the mixture during storage; sludge from slaughterhouse wastewater

In case of peat this change (85%) is higher than the lost of humidity (50% - Fig. 2), while both are similar in case of bentonite (50%, Fig. 5, 56%, Fig. 2). This may suggest that in the mixtures with peat (similarly with sawdust) decomposition of proteineous compounds takes place. The proteins decomposition is a positive effect due to the loss of odor nuisance (the result of putrefaction). In the mixture of sludges with peat and chalk the odor has disappeared already after 3 - 4 days (the best results).

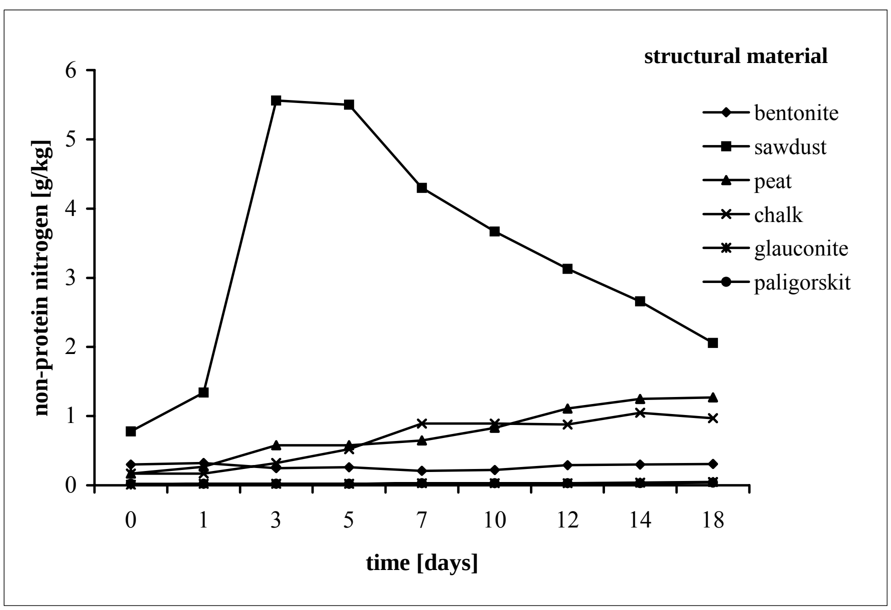

Figure 6. Changes of the non-protein Kjeldahl nitrogen content in the mixtures during storage; sludge from fish industry wastewater

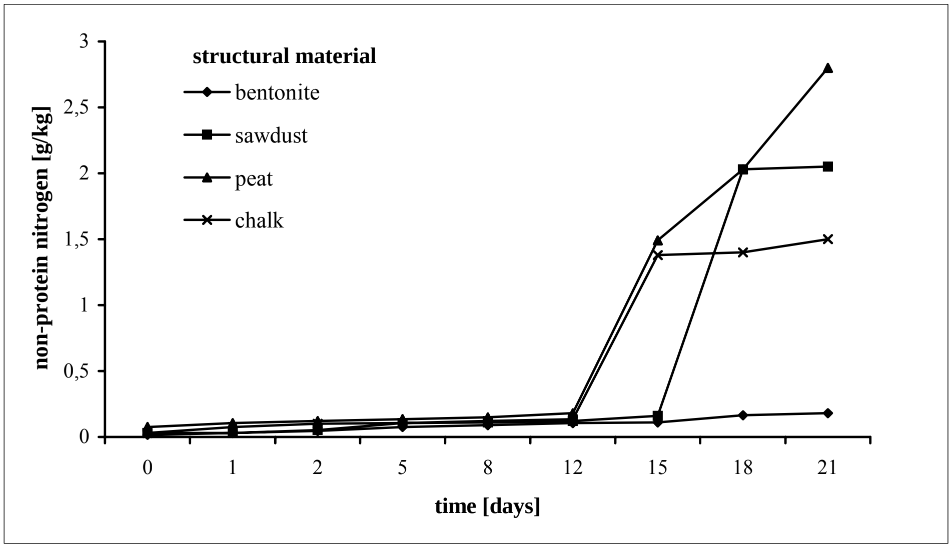

Figure 7. Changes of the non-protein Kjeldahl nitrogen content in the mixtures during storage; sludge from slaughterhouse wastewater

Analyzing Figs 6 and 7 in which the changes of non-protein Kjeldahl nitrogen are presented one can observe that the content of this form of nitrogen is very low. However, in case of slaughterhouse wastewater sludge it rapidly rises after 12-15 days of storage (except the sample with bentonite, Fig. 7) and in case of fish processing wastewater sludge with sawdust it rises alredy after two days (Fig. 6). This rise is a result of proteins decomposition, and formation other forms of N-compounds.

CONCLUSIONS

Summarizing the above presented results one can state that mixing of post-coagulation sludge with structural material is a promising way of sludge management. The problems with odors during storage has been solved effectively in case of all used materials, however chalk and peat appeared to be the most effective. All mixtures were resistant to moulds growth and their stability and consistency was sufficient for transport. The products can be used directly as a fertilizing material or utilized for compost production. However, the additional microbiological investigations are obviously needed.

When evaluate the usefulness of structural materials for dewatering and stabilization of post-coagulation sludges it became evident that materials of organic origin (sawdust, peat) are able to absorb the amount of sludge higher than materials of mineral origin (glauconite, bentonite, paligorskit). Besides, they are very good structural material for composting. Thus it can be suggested to use them, rather than inorganic (mineral) sorbents.

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