

оцінка впливу мінеральних добрив на навколишнє природне середовище, тощо). Друга група (освітні завдання) пов'язана з розробленням і впровадженням у навчальний процес курсів з основ сталого розвитку, проведенням заходів для школярів (квести, конкурси, презентації) та організацією інформаційно-просвітницьких кампаній для покращення обізнаності населення з проблематикою сталого розвитку.

**Висновок.** Створення лабораторії сталого розвитку сприятиме активізації міждисциплінарних наукових досліджень, модернізації освіти, а також популяризації ідей сталого розвитку у суспільстві.

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## SUSTAINABLE METHODS OF POULTRY LITTER UTILIZATION

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## СТАЛІ МЕТОДИ УТИЛІЗАЦІЇ ВІДХОДІВ ПТАХІВНИЦТВА

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## УСТОЙЧИВЫЕ МЕТОДЫ УТИЛИЗАЦИИ ОТХОДОВ ПТИЦЕВОДСТВА

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*The research is aimed for assessment of sustainability of such methods of poultry litter utilization as combustion, gasification and hydrothermal carbonization.*

**Key words:** combustion, gasification, hydrothermal carbonization, sustainable development, poultry litter

*Дослідження спрямовано на оцінку сталості таких методів утилізації відходів птахівництва, як спалювання, газифікація та гідротермокарбонізація.*

**Ключові слова:** спалювання, газифікація, гідротермокарбонізація, сталий розвиток, відходи птахівництва

*Исследование направлено на оценку устойчивости таких методов утилизации отходов птицеводства, как сжигание, газификация и гидротермокарбонизация.*

**Ключевые слова:** сжигание, газификация, гидротермокарбонизация, устойчивое развитие, отходы птицеводства

## **Introduction**

The poultry production is one of the rapidly growing sectors of agriculture in Ukraine. Considering massive environmental impact of landfilled poultry litter, especially to soil acidification, eco-friendly waste treatment technologies are required in order to implement sustainable nature management approach in this sector. This research includes brief overview of alternative poultry litter utilization methods: combustion, gasification and hydrothermal carbonization (HTC). Environmental and engineering aspects have been reviewed.

## **Problem statement**

Alternative poultry waste treatment technologies should be assessed from environmental point of view as well as their further application in Ukrainian agriculture sector.

## **Analysis of published data**

Poultry litter (PL) is heterogeneous waste consisting of bedding material, faeces, urine, feathers and waste feed and is the most suitable manure feedstock for thermal conversion processes. In addition, use of poultry litter as organic fertilizer in agriculture has become less acceptable due to excess nutrient in the soil [1]. In the past, several reviews [1-3] explored the advances in disposal technology for poultry litter. Experiments with producing bioenergy from the livestock waste has clearly indicated that thermochemical conversion processes have the capability to convert animal by-products into combustible gases, bio-oils and solid product which can be used as a soil amendment/fertilizer [1].

## **Hydrothermal carbonization of poultry litter**

The hydrothermal carbonization process is regarded as an eco-friendly thermochemical process suitable for wet biomass and biowaste. The main advantages of the hydrothermal carbonization process are the considerable decrease in weight and volume, the ability to convert wet biomass and biowaste into a sterile material and large amounts of co-produced heat [1]. During hydrothermal carbonization processing, the wet biomass and biowaste undergoes a number of complex chemical reactions such as dehydration, decarboxylation, hydrolysis and aromatization reactions [1]. As a result, a solid residue (named hydrochar or HC), a liquid by-product and some gaseous products are formed.

Among of the main aims of the hydrothermal carbonization process and the point-of-interest for study [1] is to produce a (HC) with better fuel and chemical properties [1].

## **Fluidized-bed combustion (FBC) of poultry litter**

Poultry litter is recognized as a biomass fuel, and is generally a free-flowing, granular material, with a consistency and physical appearance similar to a mixture of wood chips and sawdust. It can vary from wet compacted manure to a dry dusty powder [2]. It is generally recognized as a low value fuel due to its comparatively high moisture and ash contents. The moisture content of poultry litter is inconstant and this impacts on the homogeneity and the lower heating value (LHV) of the fuel, which can range from 9 GJ per metric ton to 13 GJ per metric ton. The use of poultry litter as an alternative fuel source on a large scale basis has been carried out since Fibropower opened their poultry litter-fired power plant, at Eye in Suffolk UK in November 1993 [2].

Fluidized-bed technology is one of the most promising methods for biomass combustion, due to its ability to handle fuels of different composition with good combustion efficiency and low emissions. Fluidized-bed combustion has been selected in several combustion trials utilizing poultry litter, and it is used commercially for the combustion of low-quality fossil fuels, such as peat, and the co-combustion of biomass fuels [2]. However, the variable mineral content of biomass can cause operational problems including fouling, slagging and possible corrosion during combustion applications. Hence, much of the current research surrounding biomass fuels is aimed to ash formation and the mechanisms of ash deposition and agglomeration [2].

Use of poultry litter as a combustion fuel concentrates the nutrients of the litter in an inorganic, sterile form. Nitrogen is lost during combustion, while phosphorous and potassium are both retained, as well as several other macro and micro nutrients [2].

### **Gasification of poultry litter**

Gasification is an advanced thermochemical treatment technology which transforms the solid manure biomass into a gaseous energy carrier called syngas or product gas [3]. Gasification offers some advantages over conventional combustion as mentioned in literature reference [3]. The gas can be easily transported and gas handling is easier compared to a solid biomass and the gas volume is less, which requires smaller equipment. Moreover, the gas could be distributed to individual houses or units to be used as a fuel for cooking or heating. Gasification produces less sulfurous and nitrous oxides as emissions due to the lower intake of oxygen and treatment temperature [3].

Due to the large amounts of produced ash and tar the use of PL for gasification might have to be seen primarily as a waste treatment option, while producing energy as a useful side product, rather than aiming to achieve high process performance [3].

### **Conclusions**

The research has highlighted significance and viability of thermal conversion processes of poultry waste and their advantages over traditional usage of poultry litter as fertilizer. The results presented above show that poultry litter is a useful alternative source of energy.

Treatment the litter in the manner described in this article decreases waste up to 10% of original mass, alleviates environmental pollution induced by land spreading and concentrates nutrients in a sterile and easily transportable material.

All aforementioned technologies have an important role in implementing of sustainable development concepts in Ukrainian agriculture sector.

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