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Pellet Production from Different Sources of Biomass - Residues of Forest and Animal Origin. Supporting Social Entrepreneurship in Mountainous Regions

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Abstract

In mountainous areas of Greece the need for thermal energy becomes during the winter extremely high. Nowadays we try to use the most ecological and economic ways for heating and the results is an indiscriminate use of forests wood. To protect and enhance sustainable development we must find new and effective solutions. Wood pellet is one of the most common ways of fuel because it is low cost and easy to transfer and store. On the other hand in the mountainous areas of Greece there is a big quantity of animal residues mainly from sheep, goats and chicken that can be used for a percentage replacement of wood in pellet production. During this research we try to measure all the necessary properties of wood and animal residues in order to use them as a raw material for pellet production. Humidity, inorganic content, calorific value, pH, water soluble, dichloromethane and alcohol soluble were measured and reported. All the above was investigated in order to find a solution to the unemployment and the environmental protection, while it can combine profitability through solidarity and new job creation within a Social Economy innovation. The conclusion from our results provide a first data from the behavior of biomass coming from forest and animal residues which is quite encouraging and can be improved with more experimental activity.

Keywords— Pellets, Biomass, Residues of Animal Origin, Wood Residues, Mountainous Areas, Rural Entrepreneurship, Mechanism for Social Economy

Introduction

Nowadays, the energy used for heating is from non-renewable energy resources like coal, oil, gas, etc. However, the reduction of these resources and environmental pollution are forcing research and development of new renewable energy resources. The biomass energy is one of the renewable resources that hold an important position in the energy system (Apostolakis et al. 1987, FAO STAT 1988). Thus the replacement of fossil fuels with biomass energy is a good way to mitigate the global warming due to greenhouse. In the effort of discovery of alternative sources of energy based on the biomass and observing the existence of important quantities from biomass and mostly from animal waste products in several places in Greece (Gemptos 1992), was organized an experimental process that concerns in the potential production of thermal energy with the use of biofuel from biomass and mostly from animal waste products.

Biomass is the organic matter, which emanates from living or recently living organisms. As biomass we include wood, animal waste as well as the plants and forestall remains (pruning, straw, chippings, firewood, kernel etc.) (Mc Nutt et al. 1992).

Practically we can say that as biomass is included each material which has plant or animal origin (direct or indirect). The chemical constitution of biomass presents high and variable content in humidity and fiber structure, which is constituted from lignin, carbohydrates also can include nitrogen and small quantities of other individuals, included, alkaline and heavy metals (Ntalos 2000).

The sources of biomass origin vary for each organic material. The biomass is constituted by carbon, hydrogen and oxygen, and it can be as straw, paper and his waste, the waste of slaughterhouses, the organic waste of food industries, the outcast plant oils, remains of food and can be used with different ways in different systems of bioenergy for the production of energy, heat and fuels for transportation.

Another source could be from stock raising. The main animal waste product is animal excreta. The question of their effective management becomes still more intense at the mass stockfarming of animals (usually cattle, pigs and poultry) in limited spaces.

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The best way of waste management is their utilization for the production of bioenergy. More concretely, with the help of technology of anaerobic fermentation the humid animal waste is changed in biogas, one alternative and "green" biofuel. Afterwards its production, the biogas is supplied for co-production of electric energy and heat, which are become very important income. Additional income can be from the commercial exploitation of digested remains of all the above as biological fertilizer.

The biomass, consequently, that is received by the stockfarming of animals as waste, are not useless, but contrary constitutes a very important source of income for the producer as well as the only way of electric energy production with friendly for the environment way.

The potential for using waste from stock farming residues to replace wood as raw materials for energy production has received considerable attention in recent years (Deppe and Ernst, 1991, Seber and Lloyd, 1996, Roffael, 1997 and Hague et al., 1998).

Some of the animal residues which could replace wood as the raw material for energy production is chicken and sheep excreta.

As scientists are increasingly engaging in "hunting" new energy sources, energy production from animal excreta is gaining interest. The experimental process that will be presented in this paper contains the following stage:

Evaluate of the energy derivative from the combustion of animal waste products.
Chemical analysis of animal waste products .
And finally, the possibility of production briquettes or pellets based on animal waste products at 100% and by mixing with forestal remains.

Materials and Methods

The raw material for this study consisted of chicken and sheep excreta, which were collected in April 2015 from Northern Greece.

For the evaluation of certain basic characteristics and properties of the excreta (Moisture content etc.) representative samples from each different kind of origin (chicken and sheep) were chosen. Extractives and ash content was determined in material of each variety. The determination of extractives content solubles in hot water, alcohol-benzene (Co Merc), and dichloromethane (Co Ridel-de Haen) was carried out according to ASTM standards D1110-84, D1107-84 and D1108-84 (ASTM-D, 1984). Ash content were determined according to EN standards EN 14775. The acidity was measured in an extract solution made by 2 g excreta flour added to 40 ml water and stored for 24 h at 20±3 °C (Passialis, 1988).

Figure 1: The Material (Sheep Excreta) in The Hammer Mill

After harvesting, the moisture measurement was calculated according to European norms, EN 14774 (EN, 2009). The excreta were chipped in a hammermill with an 8 mm round hole screen and the particles were dried with a laboratory made hot air dryer afterwards, from a moisture ranged between 40 and 50% down to 3% m.c. The whole procedure of chipping was carried out separately for each different origin. In addition, the calorific value were determined with a bomb type calorimeter.

Results and Discussion

Some basic characteristics and properties of sheep and chicken excreta are shown in the following tables. In Table 1 moisture content of different biomass resources are mentioned during their harvesting. The mean values of moisture content ranged between 8% and 90% but the moisture content of our material was 63% and 136% for chicken and sheep excreta respectively as seen in Table 2 which is quite a big amount of moisture that has to be removed. In Table 2 the pH values are also presented. It is important to note that the extracts (water, dichloromethane, alcohol solubles) are also in big amount (Table 3,4). The values of ash content are shown in Table 5. A comparison between these values and those given by Fengel and Wegener (1984) show that the excreta have higher hot water extractives and very high ash content than the wood of common forest species.

Table 1:
Moisture Content in Different Biomass Resources

Biomass resource	Moisture content
Wood chips	10-60 %
Wood Pellets	8-12 %
Straw	20-30 %
Sawn dust	15-60 %
Cotton residues	10-20 %
Switchgrass	30-70 %
Baggase	40-60 %
Cow excreta	88-94 %
Pig excreta	90-97 %
Sweet sorgum	20-70 %

Table 2:
Moisture Content and pH Value of Chicken and Sheep Excreta

Biomass resource	Moisture content	pH
Sheep excreta	136 %	4,1
Chicken excreta	63 %	3,9

Table 3:
Water, Dichoromethane, Alcohol Solubles of Sheep Excreta

Hot water extracts	Dichlomethane extracts	Alcohol extracts
46,55%	11,49%	9,9 %

Table 4:
Water, Dichoromethane, Alcohol Solubles of Chicken Excreta

Hot water extracts	Dichlomethane extracts	Alcohol extracts
17,95%	7,27%	5,95%

Table 5:
Ash Content of Chicken and Sheep Excreta

	Chicken excreta ash content	Sheep excreta ash content
Average	23,5%	12,75 %
Min	22,8 %	9,6 %
Max	24,2 %	15,9 %
STDEV	0,98 %	4,45 %

Table 6:
Calorific Value of Chicken and Sheep Excreta

Chicken excreta calorific value (cal/gr)	Sheep excreta calorific value (cal/gr)
1840,5	3121

Conclusions

The sheep and chicken excreta is the main residues in Greece as they are the main animals in stock raising. On the other hand there is a need for big quantities for thermal energy which for the moment is providing from wood

burning. The sheep and chicken excreta have more moisture content when we collect them (Figure 2.) but the dichloromethane solubles as the alcohol solubles are quite the same as in common wood Mediterranean species.

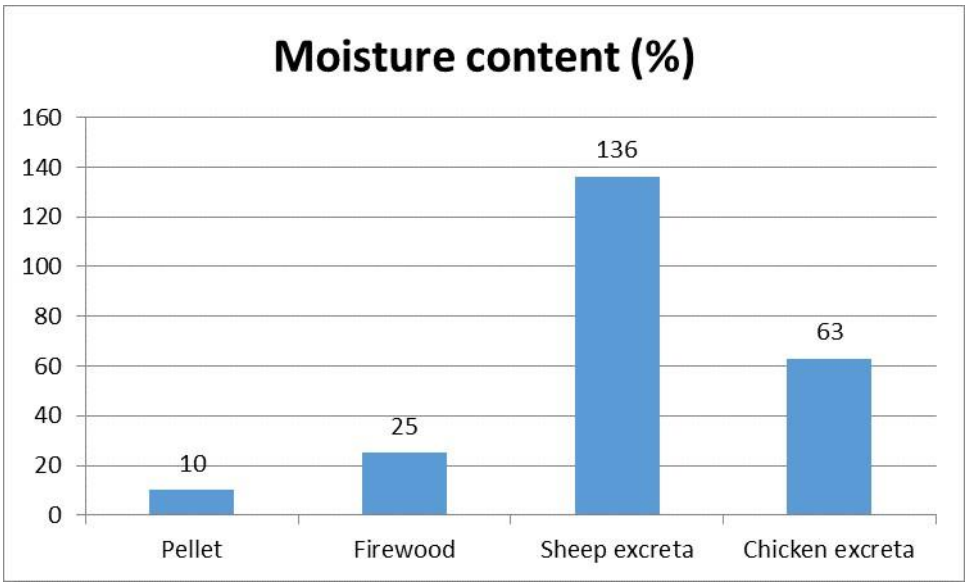

Figure 2: Moisture Content of Pellet, Wood and Sheep and Chicken Excreta

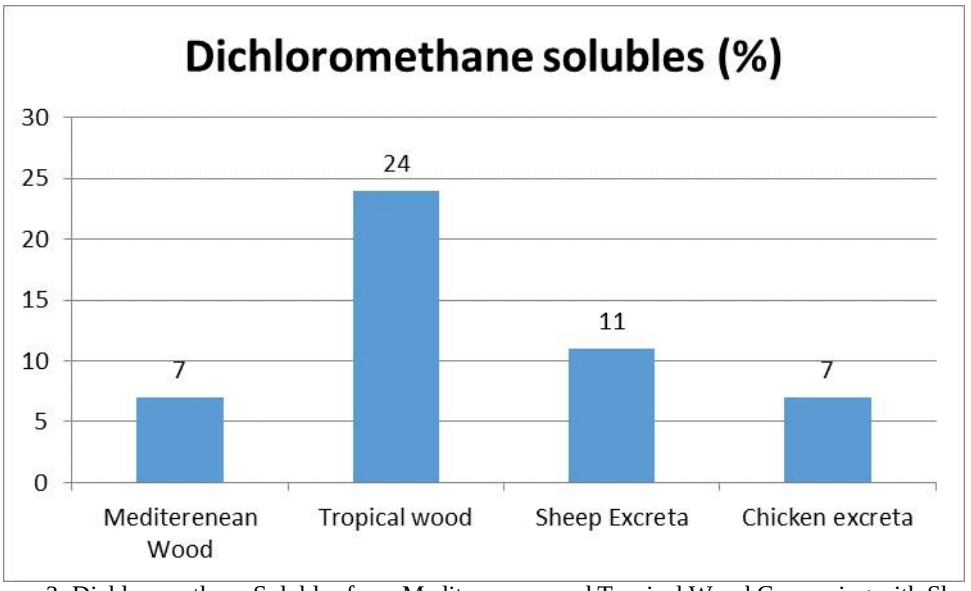

Figure 3: Dichloromethane Solubles from Mediterranean and Tropical Wood Comparing with Sheep and Chicken Excreta

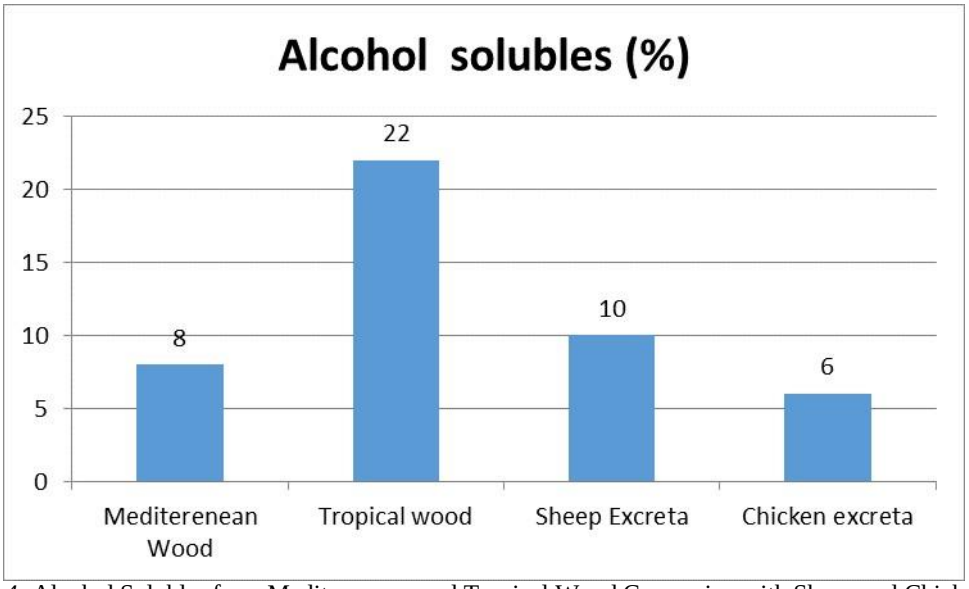

Figure 4: Alcohol Solubles from Mediterranean and Tropical Wood Comparing with Sheep and Chicken Excreta

Sheep excreta appeared to be with higher calorific value that is very close to the wood (Figure 5.) but the main problem for both of our material is the big ash content that they have, which for the moment keep these materials away for the domestic use.

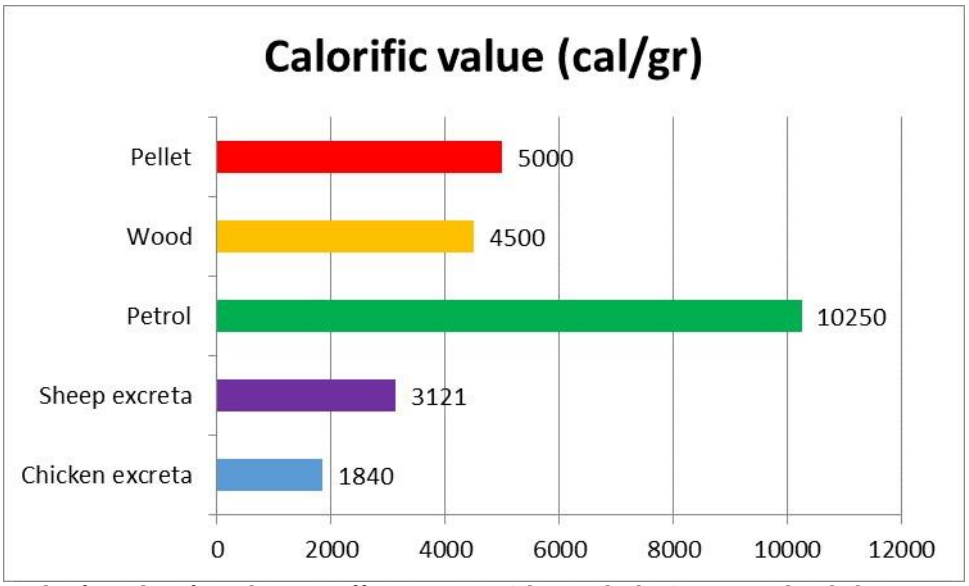

Figure 5: Calorific Values form the two Different Excreta (Sheep, Chicken) Compared with the Common Fuels

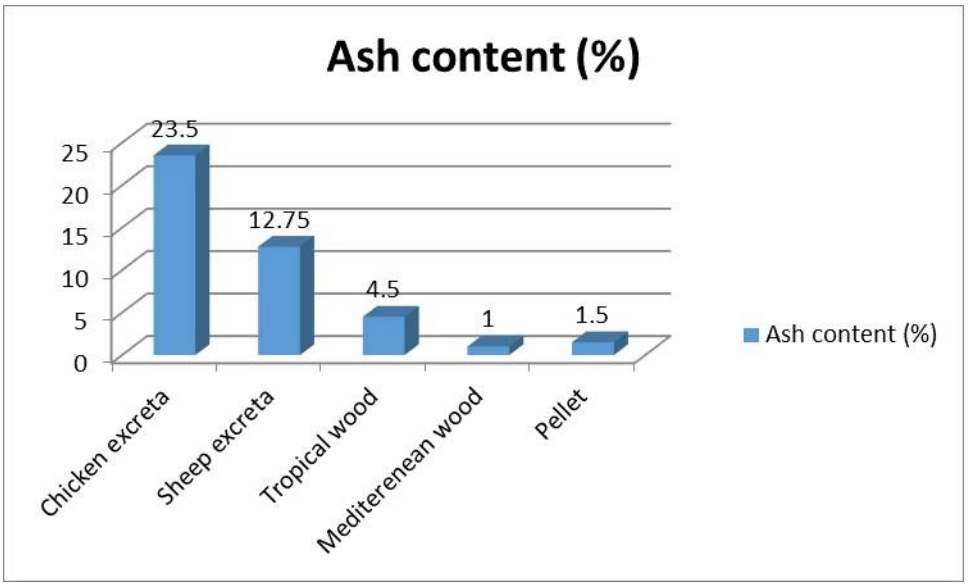

Figure 6: Ash Content of Chicken and Sheep Excreta Comparing with Tropical and Mediterranean Wood and Pellet

Further research should be carried out in order to find appropriate methods for burning these two materials mixed with the proper amount of wood in order to reach ash content less than 5% for industrial use and lower than 1,5% for domestic use.

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