

## POSSIBILITIES OF VIRGINIA TOBACCO STALKS UTILIZATION

Vesna Radojičić<sup>1</sup>, Olivera Ećim-Djurić<sup>1</sup>, Marija Srbinoska<sup>2</sup>, Nermina Djulančić<sup>3</sup>,  
Gordana Kulić<sup>1</sup>

<sup>1</sup>*University of Belgrade, Faculty of Agriculture, 11080 Belgrade, Republic of Serbia*  
*e-mail: [mntabacco@agrif.bg.ac.rs](mailto:mntabacco@agrif.bg.ac.rs)*

<sup>2</sup>*University St. Kliment Ohridski-Bitola, Scientific Tobacco Institute, 7500 Prilep,*  
*Republic of Macedonia*

<sup>3</sup>*University of Sarajevo, Faculty of Agriculture and Food Science, 71000 Sarajevo,*  
*Bosnia and Herzegovina*

### ABSTRACT

The aim of the study was to determine the possibility of using the stalks of Virginia tobacco. Special attention was paid to estimation of the energy potential, through prediction of higher heating value (HHV), based on the lignin and ash content.

The usage of tobacco stalks will have significant environmental impact: it can solve the problem with the waste, giving the possibility to include it in the total biomass of Serbia, together with other wastes of agricultural production.

The results of the research reveal that tobacco waste can be used as raw material for production of proteins and cellulose, and certain amount can be used in energetic purposes, for production of biogas, bio-ethanol, pellets and briquettes, affording environmentally acceptable and energy-valuable products. The fact that there are no written data about the chemical composition of tobacco stalks from the Republic of Serbia gives special significance to this study.

**Key words:** Virginia, tobacco stalks, biomass, higher heating value (HHV), lignin, cellulose

### МОЖНОСТ ЗА ИСКОРИСТУВАЊЕ НА СТЕБЛА ОД ТУТУНОТ ТИП ВИРЦИНИЈА

Ова истражување има за цел да се утврди можноста за користење на стеблото од тутунот тип Вирџинија. Посебно внимание е посветено на испитувањето на енергетскиот потенцијал и утврдувањето на вредноста на горната топлотна моќ (HHV), врз основа на содржината на лигнин и пепел.

Користењето на тутунските стебла ќе има значително еколошко влијание, со што се решава проблемот со отпадот и се дава можност истите, заедно со други остатоци од земјоделското производство, да бидат вклучени во вкупната биомаса на Република Србија.

Од резултатите на ова истражување може да се заклучи дека остатоците од тутунот можат да се користат како сировини за производство на протеини и целулоза, а одредена количина од овој материјал може да се употреби за енергетски цели, во производството на биогас, биоетанол, пелети и брикети, при што крајниот производ ќе биде еколошки прифатлив и енергетски употреблив. Фактот дека не постојат податоци за хемискиот состав на стеблата од тутунот произведен во Република Србија му дава поголема важност на ова истражување.

**Клучни зборови:** вирџинија, тутунски стебла, биомаса, горна топлотна моќ (HHV), лигнин, целулоза

## INTRODUCTION

According to the European Union Directive 2001/77/EC, the biomass is a biodegradable fraction of the product, it is the waste and remains of agriculture (including the plant and animal substances), in forestry and supporting industry, also it is part of the industrial waste.

Republic of Serbia has relatively great potential of biomass, mainly because of the waste from the primary agricultural production as the straw (wheat, barley, oats and soybeans) and corn waste (Jovanović and Parović, 2009). It is evaluated that there are 12.5 million tons of biomass produced in R. Serbia each year.

It should be emphasized that tobacco stalks have significant impact on the total biomass in agricultural production. Tobacco stalks, which according to the categorization (Radojičić et al., 2009) are classified in green tobacco waste, also have significant impact in the total biomass.

Each year, large amounts of tobacco stalks are left in the field after harvest. Smaller part of them (approx. one quarter) is usually ploughed and a large amount is used as a waste or is burned in the field, which results in loss of recourses and environmental pollution. According to the data of the Statistical Office (Statistical Yearbook, 2011), large-leaf tobacco is grown on 5407 hectares, of which 4410 hectares are planted with Virginia tobacco.

The average yield of Virginia tobacco is 20.000 – 25.000 stalks per ha and the average weight of dry stalks is 300 – 400 g. It means a yield of 6.000 – 10.000 kg dried stalks per hectare, which can be further used in production of a variety of products. In Serbia, about 76 000 tons of tobacco stalks remain in field each year and they

don't have any economic value.

Tobacco is mainly produced because of its leaves, which can be used for production of a variety of products (cigarettes, cigars, pipe tobacco, etc.). Literature data show other ways of use of tobacco, for production of organic acids (citric, maleic, oxalic acid), nicotine acid, proteins, paper, bioethanol, biogas, as well as inorganic fertilizer (Sun and Cheng, 2002; Martín et al., 2002; Chaturvedi et al. 2008; Martin et al. 2008; Shakhes et al. 2011; Radojičić and Kulić, 2011; Kapadiya et al. 2010;).

It is important to mention that tobacco contains lignin and relatively high concentration of cellulose. The highest concentration of cellulose is in the tobacco stalks - 35-40% of dry substance (Pesevski et al. 2010). Such chemical composition is suitable for the production of biofuels.

In near future, the usage of lignocellulosic biomass in the process of biofuels production will be necessary, because it is expected that fossil fuels will be replaced by renewable sustainable alternatives (Semenčenko et al., 2011). In addition, the high cellulose concentration in the stalks is very important secondary raw material for production of paper, cardboard, textile, cotton, flax and other plant fibers (Radojičić et al. 2011; Gao et al. 2011).

Nowadays tobacco stalks are very interesting product for the textile industry. They can be used in the production of colors and textile fibers. Up to 30 shades of a color can be produced in low temperatures by using tobacco combined with relatively small amount of water. Fibers are antibacterial and can be combined with cotton, silk and kashmir (Besucher newsletter, 2012).

## MATERIAL AND METHODS

The stalks of Virginia tobacco from the production area of Vojvodina (Srem – Golubnici), collected from the field after harvest are used as a material for this research. First, stalks were cut into smaller pieces to about 3-5 cm length and then ground by a Retsch ZM1 mill (Germany), than sieved through a series of vibrating sieves. Fractions of 0.5 – 1.0 mm particulate size were taken for analyses of chemical composition.

The methods developed by the National Renewable Energy laboratory (NREL) are used as the most commonly employed method for determination of the lignin and all extractive soluble substances in organic solvents, ashes and moisture in wood and non-wood samples (NREL/TP-510-42619, 42622, 2005 and NREL/TP-510-42618, 42621, 2008).

The moisture content was determined by drying at 105°C till constant mass. The ash content in stalk was determined by dry oxidation at 575 °C till constant mass.

The procedure of acid insoluble lignin consists of treating the stalk samples with 72% sulfuric acid, followed by 1h heating at 30°C, with stirring. After adjusting the acid concentration to 4 % w/w by adding deionized water, the mixture was autoclaved

at temperature 125 °C and pressure 15 psi, for 1h.

Acid insoluble lignin was defined as the residue corrected for acid-insoluble ash, retained on a medium porosity filter crucible after the primary 72% and secondary 4% H<sub>2</sub>SO<sub>4</sub> hydrolysis steps.

Reducing sugars were determined by the picric acid colorimetric method, while the nicotine level was determined using a UV spectrophotometry and procedure described by Wang et al. (1990).

The cellulose content was determined following the method of Kürschner-Hanack, by treating the sample with a mixture of nitric acid and acetic acid under reflux, during four cycles per 1h. Then the cellulose was filtered, washed, dried and weighed.

The nitrogen content (N) was determined by *Kjeldahl* method. The nitrogen was quantified by mineralization within a strong acid medium, containing 98% sulfuric acid, followed by steam distillation and titrimetric determination of NH<sup>+</sup><sub>4</sub>/NH<sub>3</sub>.

The results of the chemical composition analyzes of the samples of tobacco stalks are estimated on dry weight basis. All analyses are performed in triplicate.

## RESULTS AND DISCUSSION

Chemical analysis of the stalks of Virginia

tobacco is presented in Table 1.

**Table 1. Chemical analysis of the stalks of Virginia tobacco**

Parameters	Moisture (%)	Protein (%)	Nicotine (%)	Sugars (%)	Cellulose (%)	Acid insoluble Lignin (%)	Ashes (%)
	5.21	13.87	0.343	7.54	35.30	15.99	6.19

According to the available literature data (Leffingwell, 1999), the average content of proteins in Virginia tobacco leaves is 8 - 10 %. The stalks have higher protein content. These high values can be a result of the

use of nitrogen fertilizers, different climate conditions or other conditions during the process of tobacco cultivation. The fact that Virginia tobacco has such a high content of proteins gives a possibility of their

extraction from tobacco stalks, purification and use in therapeutic and other purposes.

The nicotine content in Virginia tobacco leaves is about 2 % (Leffingwell, 1999), while in the stalks it is significantly lower. The results of our research in Table 1 are in accordance with previous mentioned data. The nicotine can be extracted from the stalks and used in the production of pesticides in pharmaceutical industry. Therefore the toxicity of the biomass is reduced and allows further usage.

Sugar content in the leaves of Virginia tobacco is 13–22 % (Leffingwell, 1999). As expected, tobacco stalks have significantly lower content of sugar compared to the leaves (Table 1). However, this content (7.54 %) is much higher compared to other tobacco types (e.g. the leaves of Burley tobacco contain only 0.01 – 2 % sugar). Accordingly, the stalks of Virginia tobacco

can be used in the production of alcohol and biogas.

According to literature data, tobacco stalks contain 35 – 36 % cellulose, the main rib 10 – 15 % and the lamina 10 – 12% (Leffingwell, 1999).

The results of our research are in accordance with literature data. The analysis of the obtained value for cellulose content and the reviewed data about the amount of stalks in Virginia tobacco reveal that up to 3.530 kg cellulose can be obtained from one hectare. The content of lignin in tobacco is 4 – 5 % and the stalks may contain 20 – 30 % lignin (Leffingwell, 1999). The result shows that the stalk percentage of Virginia tobacco (Table 1) is lower than that found in literature.

According to Demirbas (2001) formula, the relation between the content of lignin and heating power is

$$HHV = 0,0889 \cdot (L) + 16,8218,$$

Where:

L is the lignin content.

We calculated high heating value in the stalks of Virginia tobacco (18.243 MJ/kg), which represents a significant energetic potential.

According to Brkić et al. (2007), the heating power of straw is about 15 MJ/kg, that of wood 18.6 MJ/kg, of fuel oil 42 MJ/kg and of diesel fuel 41 MJ/kg. Generally, the heating power of the biomass pellets, which are produced from the wastes of the agricultural products, is from 13 to 18 MJ/kg (Agroinfotel, 2014).

If we compare the data on the tobacco stalks heating power with the above values, it can be concluded that the usage of Virginia tobacco stalks for the production of briquettes and pellets is profitable because they have high calorific value.

Tobacco stalks contain lower ashes content

compared to the leaves (the average value is 7.89 %). The tobacco stalks dried in controlled conditions have the lowest ashes content (Leffingwell, 1999). Most of the plants contain about 3 % mineral matter.

Tobacco contains higher content of ashes compared to the leaves of other plants. Based on the data of our experiment (Table 1), the ashes content is lower than expected (6.19 %), which can be considered as a good result.

In fact, the possibility of biomass combustion is very low and the ash quantity is insignificant, which is a positive feature, compared to the fossil fuels.

The formula developed by Sheng and Azevedo (2005) shows the correlation between the ashes content and heating power:

$$HHV = 19,914 - 0,2324 \cdot Ash$$

From this formula a high heating value of the Virginia tobacco stalks can be recorded, reaching up to 18.475 MJ/kg. The heating power which is predictable

on the bases of lignin content and the calculation of the ashes content indicate the possibility of using the stalks of tobacco type Virginia for energetic needs.

## CONCLUSIONS

This work is related to determination of the possibility of using the stalks of Virginia tobacco, on the basis of chemical analyses. From the results obtained, the following conclusions can be drawn:

- The protein content (13.87%) is higher than expected; proteins can be isolated and part of them can be used for various purposes, the leftover can be used as a biomass.
- The nicotine content (0.343 %) is within expected range; it can be isolated from the stalks and used in pharmaceutical industry or in pesticide production, which lowers the toxicity of the biomass;
- The sugars content (7.54 %) is higher when compared to the other tobacco types; the stalks of Virginia tobacco are exceptionally useful for biogas and ethanol production;
- The cellulose content (35.30 %) is higher, which indicates that the stalks of Virginia

tobacco have high potential for cellulose production;

- The heating power calculated on the basis of lignin (18.243 MJ/kg) and ashes content (18.475 MJ/kg) shows that the stalks of tobacco type Virginia are significant energetic potential.

The agricultural waste from tobacco is exploited in order to obtain a secondary product, which can be used in other industries, for various purposes. This fact is not well known in R. Serbia as in the other countries from the region. According to the results of the research, tobacco stalks can be used in production of some of the above mentioned products as well as for energetic needs. In this way, the wanted economic effect would be achieved, which is highly important for reduction of environmental pollution.

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