Energetska valorizacija biomase kulture *Sida hermaphrodita*

Valorization of energy properties of *Sida hermaphrodita*

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Poljoprivredna biomasa
Agricultural biomass

Ostaci:

- **ratarske proizvodnje (uljana repica, soja, kukuruz, šećerna repa, slama, kukuruzovina, oklasak),**
- **voćarsko-vinogradarske proizvodnje (orezani ostaci),**
- **dorade i prerade poljoprivrednih sirovina u prehrambenoj industriji (komina grožđa, komina masline, komina uljarica, koštice voća, ljuske jezgričavog voća),**

Residues of:

- *crop production (oilseed rape, soy, maize, sugar beet, straw, corn stalks, corn cobs),*
- *orchard - vineyard production (pruning residues),*
- *processing and finishing of agricultural raw materials in the food industry (grape cake, olive cake, oilseeds cakes, fruit pits, and shells),*

Poljoprivredna biomasa
Agricultural biomass

Ostaci iz:

- **povrćarstva i ukrasne hortikulture (otpad iz vrtova i redovnog održavanja parkova),**
- **stočarske proizvodnje (gnoj, gnojnica, klaonički otpad),**

Brzorastuće energetske kulture (*Miscanthus sp., Arundo donax* L., *Sorghum bicolor, Phalaris arundinacea*, *Sida hermaphrodita*).

Residues of:

- *vegetables and ornamental horticulture (garden waste and regular park maintenance),*
- *livestock production (manure, slaughterhouse waste),*

Fast growing energy crops (Miscanthus sp., Arundo donax L., Sorghum bicolor, Phalaris arundinacea, Sida hermaphrodita).

Energetske kulture

Energy crops

Miscanthus sp.

Arundo donax L.

Panicum vergatum

Miscanthus x giganteus

Sida hermaphrodita

Canabis sativa

Sida hermaphrodita

- **Sterilna kultura iz porodice sljezova (*Malvaceae*),**
- **Prirodno stanište je jugoistočna obala SAD-a,**
- **Niski zahtjevi u odnosu na kvalitetu tla za uzgoj,**
- **Prosječna visina biljke u trećoj godini 3 m,**

- *Sterile cultivar from the family of rapeseeds (Malvaceae),*
- *Natural habitat: south-east coast of USA,*
- *Low demands on soil quality for breeding,*
- *Average plant height in the third year 3 m,*

Sida hermaphrodita

- **Uobičajeni sklop: 10.000-20.000 biljaka/ha,**
- **Prosječan prinos treće godine 12-25 t ST/ha (u ovisnosti o tipu tla, meteorološkim prilikama, sklopu, pojavi štetočinja),**
- **Životni vijek oko 20 godina,**
- **Medonosna biljka s više cvatnji godišnje.**

- *Usual assemply: 10,000-20,000 plants/ha,*
- *Average yield of the third year 12-25 t ST/ha (depending on the type of soil, meteorological conditions, insects, pests),*
- *Life time about 20 years,*
- *Honey plant with more blooms annually.*

Mogućnost korištenja energetskih kultura

Utilization of energy crops

- ✓ Tekuća biogoriva - lignocelulozni etanol
- ✓ Plinovita biogoriva - bioplin
- ✓ **Kruta biogoriva - sječka, peleti i briketi**

- ✓ Liquid biofuels - Lignocellulose ethanol
- ✓ Gaseous biofuels - biogas
- ✓ **Solid biofuels - chips, pellets and briquettes**

Valorizacija krutih biogoriva za proces izgaranja

Valorization of solid biofuels - for the combustion process

- **Gorive tvari → ugljik, vodik, sumpor, kisik, hlapive tvari,**
- **Negorive tvari → voda, dušik, pepeo, fiksirani ugljik, koks,**
- **Ogrjevne vrijednosti → donja i gornja ogrjevna vrijednost,**
- **Lignocelulozni sastav → lignin, celuloza, hemiceluloza.**

- *Combustible matter: carbon, hydrogen, sulfur, oxygen, volative matter,*
- *Non-combustible matter: water, nitrogen, ash, fixed carbon, coke,*
- *Heating values: higher and lower heating values,*
- *Lignocellulose composition: lignin, cellulose, hemicellulose*.

Sida hermaphrodita na OPG "EKO-Sever"

Sida hermaphrodita on "EKO-Sever" farm

- **Površina: 10 ha**
- **Sadnja: proljeće, 2014.**
- **Sklop: 75x100 cm (12.000 presadnica/ha)**
- **Sadni materijal: presadnice**
- **3 žetvena roka: listopad, veljača, ožujak**
- *Area: 10 ha*
- *Planting: spring, 2014*
- *Assembly: 75x100 cm (12,000 seedlings/ha)*
- *Planting material: seedlings*
- *3 harvested dates: october, february, march*

Metode *Methods*

- ✓ **Suha tvar - HRN EN 18134-2:2015**
- ✓ **Hlapljive tvari - CEN/TS 15148:2009**
- ✓ **Pepeo - HRN EN ISO 18122:2015**
- ✓ **Fiksirani ugljik - EN 15148:2009**
- ✓ **Koks - CEN/TS 15148:2009**

- ✓ *Dry matter - HRN EN 18134-2:2015*
- ✓ *Volatile matter- CEN/TS 15148:2009*
- ✓ *Ash - HRN EN ISO 18122:2015*
- ✓ *Fixed carbon - EN 15148:2009*
- ✓ *Coke - CEN/TS 15148:2009*

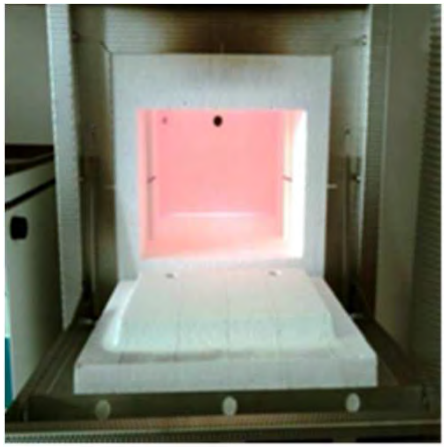
Metode *Methods*

- ✓ **Gornja i donja ogrjevna vrijednost - EN 14918:2010**
- ✓ **Dušik, ugljik,vodik - HRN EN ISO 16948:2015**
- ✓ **Sumpor - HRN EN ISO 16994:2015**
- ✓ **Kisik- računski kao ostatak**
- ✓ **Lignin, celuloza, hemiceluloza – ISO 5351-1:2002 metoda, modificirana**

- ✓ *Higher and lower heating values - EN 14918:2010*
- ✓ *Nitrogen, carbon, hydrogen- HRN EN ISO 16948:2015*
- ✓ *Sulfur- (HRN EN ISO 16994:2015)*
- ✓ *Oxygen- calculeted as the rest*
- ✓ *Lignin, cellulose, hemicellulose – modified ISO 5351-1:2002 method*

Laboratorij za istraživanje biomase i energetsku iskoristivost u poljoprivredi

Laboratory for biomass research and energy utilization in agriculture



Rezultati Results

- **Prinos suhe tvari (t/ha)**
- *Dry matter yield (t/ha)*

Prinos suhe tvari (t/ha) *Dry matter yield*	*Sida hermaphrodita*	*Miscanthus x giganteus*
Prvi rok žetve *1st harvest date*	16,70	20,13
Drugi rok žetve *2nd harvest date*	10,05	13,97
Treći rok žetve *3rd harvest date*	9,19	10,64

Rezultati Results

- **Sadržaj negorivih tvari**
- *Content of non-combustible matters*

Rok žetve Harvest date	**Vlaga (%)** Moisture	**Pepeo (%)** Ash	**Koks (%)** Coke	**Fiksirani ugljik (%)** Fixed carbon	**Dušik (%)** Nitrogen
Sida hermaphrodita					
Prvi rok žetve *1st harvest date*	45,21	3,27	12,74	3,54	1,82
Drugi rok žetve *2nd harvest date*	24,87	2,85	8,05	5,08	0,22
Treći rok žetve *3rd harvest date*	18,64	1,94	7,64	6,21	0,65
Miscanthus x giganteus					
Prvi rok žetve *1st harvest date*	54,86	1,33	11,28	9,94	0,37
Drugi rok žetve *2nd harvest date*	31,61	1,24	11,12	9,88	0,09
Treći rok žetve *3rd harvest date*	22,49	1,20	11,24	10,01	0,37

Rezultati Results

- **Sadržaj gorivih tvari te gornja i donja ogrjevna vrijednost**
- *Combustible matters and higher and lower heating values*

Rok žetve Harvest date	**Ugljik (%)** Carbon	**Sumpor (%)** Sulphur	**Vodik (%)** Hydrogen	**Kisik (%)** Oxygen	**Hlapiva tvar (%)** Volatile matter	**H_g (MJ kg^{-1})** HHV	**H_d (MJ kg^{-1})** LHV
Sida hermaphrodita							
Prvi rok žetve *1st harvest date*	46,79	0,26	6,07	45,06	84,19	17,89	16,57
Drugi rok žetve *2nd harvest date*	42,22	0,19	4,24	53,14	88,87	18,11	17,19
Treći rok žetve *3rd harvest date*	50,08	0,23	6,10	42,95	87,29	17,83	16,50
Miscanthus x giganteus							
Prvi rok žetve *1st harvest date*	49,56	0,08	4,08	46,27	88,71	18,03	17,14
Drugi rok žetve *2nd harvest date*	47,87	0,06	3,58	48,47	88,87	18,14	17,35
Treći rok žetve *3rd harvest date*	47,29	0,08	3,54	49,08	88,76	18,15	17,38

Rezultati Results

- Lignocelulozni sastav
- Lignocellulosic composition

Rok žetve *Harvest date*	**Celuloza (%)** *Cellulose*	**Hemiceluloza (%)** *Hemicellulose*	**Lignin (%)** *Lignin*
Sida hermaphrodita			
Prvi rok žetve *1st harvest date*	39,03	30,08	19,88
Drugi rok žetve *2nd harvest date*	43,89	30,10	23,68
Treći rok žetve *3rd harvest date*	45,04	27,33	25,45
Miscanthus x giganteus			
Prvi rok žetve *1st harvest date*	49,23	19,29	29,39
Drugi rok žetve *2nd harvest date*	49,25	19,30	29,31
Treći rok žetve *3rd harvest date*	49,27	19,30	28,39

Zaključci Conclusions

- ***Sida hermaphrodita* se kao energetska kultura može uzgajati u RH.**
- **Dobiveni prinosi, u ovisnosti o roku žetve, proporcionalni su sa sadržajem vlage.**
  - **u prvoj žetvi (listopad 2016.), sadržaj vlage bio je 45,21 %, uz prinos od 16,75 t ST/ha.**
  - **u drugoj i trećoj žetvi (veljača i ožujak 2017.), sadržaj vlage pao je na 24,87 % i 18,64 %, uz prinos od 10,05 t ST/ha i 9,19 t ST/ha.**

- *Sida hermaphrodita can be grown as energy crop in Republic of Croatia.*
- *It was found that the yields were, depending upon the harvest date, proportional with moisture content:*
  - *1st harvest (October 2016) -- moisture content was found to be 45.21 %, with yield of 16.75 t ST/ha.*
  - *2nd and 3rd harvest (February and March 2017) -- moisture content was found to be 24.87 % and 18.64 %, respectively, with yield of 10.05 t ST/ha and 9.19 t ST/ha, respectively.*

Zaključci Conclusions

- ✓ **Trećim rokom žetve omogućeno je neposredno skladištenje biomase bez obrade sušenjem, budući da je vlaga biomase manja od 20 %.**
- ✓ **Pepeo, kao glavni indikator kvalitete goriva, promjenom roka žetve pada te je najniži u trećem roku žetve – 1,94 %, što je na razini šumske biomase.**

- ✓ *3rd harvest date enabled direct storage of biomass, without drying, since moisture content is lower than 20 %.*
- ✓ *Ash, as the main indicator of the fuel quality, was found to be decreasing with the change of harvest date, and was found to be th elowest in the 3rd harvest date – 1.94 %, which is similar to wood biomass.*

Zaključci Conclusions

- ✓ **Donja ogrjevna vrijednost biomase *Sida hermaphrodita* kretala se od 16,57-17,19 MJ/kg te je bila najviša u drugom roku žetve.**
- ✓ **Temeljem svega navedenog, predlaže se da, u ovisnosti o klimatskim uvjetima, rokovi žetve budu drugi (veljača) i treći (ožujak), s naglaskom na treći.**

- ✓ *LHV of Sida hermaphrodita biomass was found to be 16.57-17.19 MJ/kg, and was the highest after the 2nd harvest date.*
- ✓ *Based on the above-mentioned, it can be recommended to harvest during Feburary and March, with March being the optimum.*

Hvala na pozornosti !
Thank you for your attention !

Ministarstvo poljoprivrede
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