Utilization of inedible by products from Serbian food industry for sustainable animal nutrition

Radmilo Čolović
Institute of Food Technology, Serbia
• Feed technology department was founded on July 1st, 1963, as a scientific – research institution
• Today it has grown into FEED-TO-FOOD Research Center at Institute of Food Technology specialized for dealing with problems and issues related to animal feed industry
• 18 employees in FEED-TO-FOOD Research Center:
  17 researchers (12 with PhD degree and 5 PhD students) and 1 technician
Agriculture in Serbia

- Total surface: 88.361 km²
- Arable land: 29.705% (World Bank 2016)
- Agricultural production is most prominent in Vojvodina on the fertile Pannonian Plain
- Export of agricultural products worth 3.2 billion USD (potential 10 billion)
- The export-import ratio of agricultural products was 178% in 2016
Agriculture in Serbia

- Serbia produces various agricultural products, mostly grains, fruits and vegetables:
  - Raspberries 3rd in the world (13.5 % of world production)
  - Plums 3rd in the world
  - Maize 16th in the world
  - Wheat 21st in the world
  - Sunflower 10th in the world
  - Soybean 21st in the world
  - Sugar beet 20th in the world
## Crop production in Serbia

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Territory - NSTJ</th>
<th>Period</th>
<th>Product</th>
<th>Wheat</th>
<th>Barley</th>
<th>Maize</th>
<th>Oats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Republic of Serbia</td>
<td>2016</td>
<td>Wheat, harvested area, ha</td>
<td>595118</td>
<td>91530</td>
<td>1010097</td>
<td>27536</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2017</td>
<td>Barley, harvested area, ha</td>
<td>556115</td>
<td>84687</td>
<td>1002319</td>
<td>28537</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2018</td>
<td>Rye, harvested area, ha</td>
<td>643083</td>
<td>105740</td>
<td>901753</td>
<td>26111</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Triticale, harvested area, ha</td>
<td>4891</td>
<td>23191</td>
<td>13476</td>
<td>49237</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rape seed, harvested area, ha</td>
<td>4673</td>
<td>26718</td>
<td>19376</td>
<td>53857</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sugar beet, harvested area, ha</td>
<td>4736</td>
<td>27233</td>
<td>45628</td>
<td>48125</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sunflower, harvested area, ha</td>
<td></td>
<td></td>
<td></td>
<td>239148</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Soya, harvested area, ha</td>
<td></td>
<td></td>
<td></td>
<td>196472</td>
</tr>
</tbody>
</table>
Livestock

### Livestock population, 2017

<table>
<thead>
<tr>
<th></th>
<th>Bovine animals</th>
<th>Pigs</th>
<th>Sheep</th>
<th>Goats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italy</td>
<td>6.3</td>
<td>8.6</td>
<td>7.2</td>
<td>1.0</td>
</tr>
<tr>
<td>Serbia</td>
<td>0.9</td>
<td>2.9</td>
<td>1.7</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Eurostat, 2017
Livestock

• Cattle breeding is the most frequent in Western and Central Serbia Region (46.7%), in relation to total number of cattle on the territory of the Republic of Serbia and pigs raising is the most common in Vojvodina (44.3%).

• Compared to ten-annual average (2008-2017), total number of cattle decreased by 6.5%, of pigs by 14.7%, of goats by 14.2% and of poultry by 11.1%, while total number of sheep increased by 5.6%.
Compound feed production (mil. t)
Grains and milling/starch by products as feedstuffs

- Whole grain
  - Low quality wheat for feed
  - 80% of corn in Serbia for animal feed

- Wheat Feed Flour
- Wheat Shorts
- Wheat Middlings
- Wheat Fine Bran
- Wheat Germs
- Wheat Gluten...
Oilseed meals as feedstuffs

- Total oilseed production 1.250.000t:
  - Sunflower seed 650.000t
  - Soybean 550.000t
  - Rapeseed 50.000t
- Almost 100% of sunflower seed is crushed in Serbia, with sunflower meal production of 250.000t
- A part of soybean and rapeseed is exported, and part is redirected for food, so quantities of meals are 200-250.000t of soybean meal and 10-12.000t of rapeseed meal
- The quantities of all meals are above local demands
Oilseed meals as feedstuffs

<table>
<thead>
<tr>
<th></th>
<th>Soybean meal</th>
<th>Sunflower meal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (%)</td>
<td>40 - 50</td>
<td>33 - 47</td>
</tr>
<tr>
<td>Raw fibre (%)</td>
<td>3.5 - 9</td>
<td>18 - 22</td>
</tr>
<tr>
<td>Thiamine (mg/kg)</td>
<td>3.0</td>
<td>33.0</td>
</tr>
<tr>
<td>Niacin (mg/kg)</td>
<td>30.0</td>
<td>240.0</td>
</tr>
<tr>
<td>Biotin (mg/kg)</td>
<td>0.35</td>
<td>1.00</td>
</tr>
<tr>
<td>Lysine (%)</td>
<td>2.75</td>
<td>1.70</td>
</tr>
<tr>
<td>Methionine (%)</td>
<td>0.60</td>
<td>1.00</td>
</tr>
<tr>
<td>Arginine (%)</td>
<td>3.40</td>
<td>4.10</td>
</tr>
<tr>
<td>Cystine (%)</td>
<td>0.65</td>
<td>0.80</td>
</tr>
<tr>
<td>Threonine (%)</td>
<td>1.70</td>
<td>1.65</td>
</tr>
<tr>
<td>Triptophan (%)</td>
<td>0.59</td>
<td>0.58</td>
</tr>
<tr>
<td>Phosphorus (%)</td>
<td>0.6</td>
<td>1.00</td>
</tr>
<tr>
<td>Magnesium (%)</td>
<td>0.26</td>
<td>0.50</td>
</tr>
<tr>
<td>Iodine (mg/kg)</td>
<td>0.15</td>
<td>0.70</td>
</tr>
<tr>
<td>Selenium (mg/kg)</td>
<td>0.10</td>
<td>0.70</td>
</tr>
<tr>
<td>Potassium (%)</td>
<td>2.1</td>
<td>1.1</td>
</tr>
</tbody>
</table>
## Hipro sunflower meal as feedstuff

<table>
<thead>
<tr>
<th>Reference</th>
<th>CP %</th>
<th>CF %</th>
<th>Inclusion %</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waldroup et al., 1970</td>
<td>44</td>
<td>NA</td>
<td>0-30</td>
<td>15-20% SFM can be used successfully in mash diet</td>
</tr>
<tr>
<td>Red et al., 1976</td>
<td>40</td>
<td>11.7</td>
<td>9-37</td>
<td>Comparable with SBM, Suggested level 17.5%</td>
</tr>
<tr>
<td>Delić et al., 1992</td>
<td>44</td>
<td>10</td>
<td>0-25</td>
<td>25%SFM + L-lysine + fat successfully replaced 25% SBM BWG &gt;7.2%; FE &gt; 7%;</td>
</tr>
<tr>
<td>Jakob et al., 1992</td>
<td>45</td>
<td>6.7</td>
<td>0-25</td>
<td>25% SFM + L-lysine successfully replaced SBM BWG &gt;7.2%; FE &gt; 6.5%; CW &gt;8.9%</td>
</tr>
<tr>
<td>Lević et al., 1998</td>
<td>44</td>
<td>10</td>
<td>0-25</td>
<td>SFM + L-lysine showed better nutritive results than SBM+ DL methionine BWG &gt;2.6%; FE &gt; 2.2%; MY &gt; 8.4%</td>
</tr>
<tr>
<td>Nir, 1998</td>
<td>38</td>
<td>NA</td>
<td>0-30</td>
<td>30% SFM was as efficient as 23-28% SBM in WG and FE</td>
</tr>
<tr>
<td>Dhvale, 2005</td>
<td>34</td>
<td>23</td>
<td>0-20</td>
<td>Recommended up to 20% SFM in diets</td>
</tr>
<tr>
<td>Sredanović et al., 2005</td>
<td>44</td>
<td>9.7</td>
<td>0-25</td>
<td>25% of SFM + L-lysine HCl + fat showed better nutritive results than 25% SBM; G &gt;6.3%; FE &gt; 6.52%; CW &gt; 8%</td>
</tr>
<tr>
<td>Rama et al., 2005</td>
<td>37</td>
<td>NA</td>
<td>0-20</td>
<td>SFM replaced 67% SBM in diet without affecting BWG and FE</td>
</tr>
<tr>
<td>Podobed, 2013</td>
<td>High pro</td>
<td>NA</td>
<td>NA</td>
<td>Reduction of production costs</td>
</tr>
<tr>
<td>Dadalt, et al., 2016*</td>
<td>High pro</td>
<td>NA</td>
<td>0-32</td>
<td>SFM + multi-carbohydrase supplementation no difference when compared with pea protein isolate</td>
</tr>
<tr>
<td>Waititu et al., 2018</td>
<td>High pro</td>
<td>NA</td>
<td>0-34</td>
<td>SFM + multi-enzyme mixtures replaced 75% SBM in diet without affecting productivity</td>
</tr>
</tbody>
</table>

SFM = sunflower meal; SBM = soybean meal; CP = crude protein; CF = crude fibre; WG = body weight gain; FE = feed efficiency; NA = not available; MY = meat yield per bird; CW= carcass weight

*Pigs
Hipro sunflower meal as feedstuff

Pelleting

↑ Protein
↑ Pellet hardness
↑ Water stability
↑ Pellet durability
↑ Expansion ratio

Extrusion

20% SFM2 – 40% CP

20% SFM3 – 47% CP
Soybean molasses as feedstuff

Chemical composition

<table>
<thead>
<tr>
<th></th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude Protein</td>
<td>7.92</td>
</tr>
<tr>
<td>Crude Ash</td>
<td>7.39</td>
</tr>
<tr>
<td>Crude Fat</td>
<td>3.15</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>&gt; 1</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>54.41</td>
</tr>
<tr>
<td>Total sugars</td>
<td>35.01</td>
</tr>
<tr>
<td>Succrose</td>
<td>32.08</td>
</tr>
<tr>
<td>Glucose</td>
<td>0.53</td>
</tr>
<tr>
<td>Fructose</td>
<td>1.91</td>
</tr>
<tr>
<td>Total energy (kJ/100g)</td>
<td>1141</td>
</tr>
</tbody>
</table>
Fruit processing by products as feedstuffs

- Ecological problems:
  - Placing at arable land
  - Methane, CO\textsubscript{2}, and N\textsubscript{2}O emission - Greenhouse effect

- 1 t = 125 m\textsuperscript{3} of gas (60 do 65% methane, 35 do 40% CO\textsubscript{2}).

- Anaerobic decomposition – acid rain, pollution of aquatic ecosystems
Fruit processing by products as feedstuffs

Apple pomace

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>16.95±0.01</td>
</tr>
<tr>
<td>Ash</td>
<td>2.81±0.03</td>
</tr>
<tr>
<td>Fat</td>
<td>4.29±0.02</td>
</tr>
<tr>
<td>Fibre</td>
<td>7.93±0.04</td>
</tr>
<tr>
<td>Starch</td>
<td>55.78±0.44</td>
</tr>
<tr>
<td>Total soluble sugars</td>
<td>4.33±0.10</td>
</tr>
</tbody>
</table>
Fruit processing by products as feedstuffs

• Typical problems:
  • High moisture content (up to 80%) – low storage stability
  • Storage problems
  • Needs for product drying
  • Presence of undesired substances (pesticides, mycotoxins, etc.)
  • Uneven quality
  • Limited usage...
Confectionery industry by products as feedstuffs

- Very important industry in Serbia
- Large quantities of products which are rejected for the food purposes
- Low price of the material
- Problems with application in feed mills
- Used for fermentation purposes or for small farms
Typically imported feedstuffs

- Animal origin:
  - Fish meal (all grades)
  - Fish oil (all grades)
  - Blood meal
  - Poultry meal
  - Milk replacers...

- Plant origin:
  - DDGS
  - Pea protein
  - Pea starch...

- Vitamin & Mineral:
  - Most of the components are imported
Conclusion

- Criteria for selection of feedstuffs in Serbia:
  - Nutritive value
  - Availability
  - Transporting costs – local market
  - Affordable price
  - By products of food industry – no need for further processing
  - Ecological effects (preference of seller, not buyer)
Thank you for your kind attention!