PRODUCTION OF VEGETABLE OIL AS FUEL

Arne Kyyt, Jyri Olt
Estonian University of Life Sciences
arne.kyyt@emu.ee

Abstract. There are two options for using liquid biofuel: vegetable oil or the transesterificated form, biodiesel. The chemical processing of biodiesel from vegetable oil is highly energy consuming and therefore is not a suitable option for farmers. The aim of this study was to investigate, analyze and provide explanations about the issues concerning the selection of productions appliances that are the best for local oil manufacturing in order to ensure the production of high-quality plant-oil and press-cake. To address the above issues large quantities of technical data were processed and analysed. The technology aspects of the use of plant-oil as fuel have been taken care of.

Keywords: vegetable oil, small-scale production, pressed cake, production technologies, selection of production equipment.

Introduction

Steadily rising prices of oil products and present supply problems on the world market have resulted in a serious need for alternative fuels. Another impetus for introduction of the production and use of alternative fuels arises from the requirement of reducing the CO_2 emissions generated during fuel combustion. One alternative solution is to introduce bio fuels. The use of bio fuels would contribute to several crucial functions related to environmental protection and economy. The primary argument for introduction of bio fuels comes from the Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of bio fuels or other renewable fuels for transport. This Directive provides that by 2011 the proportion of bio fuels for transport should reach 5.7 5% [1].

The basic problem in case of small-scale production consists in the physico-chemical properties of oil extracted by cold-pressing, which prevents the use of vegetable oil on the basis equivalent to the use of regular fuel. In order to ensure high reliability of machinery and adhere to residue release limits provided by law, it is necessary to choose a production technology that would guarantee the required quality criteria. Besides that one cannot disregard the pursuit for targeted chemical composition and high nutritional value required for using pressed cake as energy- and protein rich forage, considering that different animals need different feed rations. By using various production technologies it is possible to have the desired effect on the physico-chemical properties of vegetable oil and pressed cake.

Materials and methods

1. Comparison of production technologies

An overview of this topic requires a brief review of the differences of production technologies. Production planning requires understanding of the complexity level (volume of work) of different production technologies. The differences between large and small-scale production are discussed and analysed below.

Vegetable oil can be produced from oil-seed both in industrial oil halls (central oil factories, large-scale industry) with daily processing capacities up to 4000 tons of oil-seed and also in decentralised small-scale companies (local oil halls) with daily processing capacities of 0.5…25 or – in rare cases – up to 250 tons of oil-seed. As a rule, central oil-factories produce heat-treated, solvent-extracted and fully refined vegetable oils (Fig. 1), whereas local oil-mills use sustainable oil-seed processing to produce cold-pressed vegetable oils that have not been subjected to refining stages. Thus the rape-seed quality, pressing process and oil extraction (solid/liquid – extraction) have an impact on the oil quality in case of decentralised seed-processing. Figure 2 represents oil-seed processing in small-scale industry. It appears that both processes differ from each other in terms of their complexity. Furthermore, there are differences based on solvent, chemical and water consumption and with regard to wastewater and residues generation. Last, but not least – both methods have different content of oil quantity and content of pressed cake or pulp. [2]

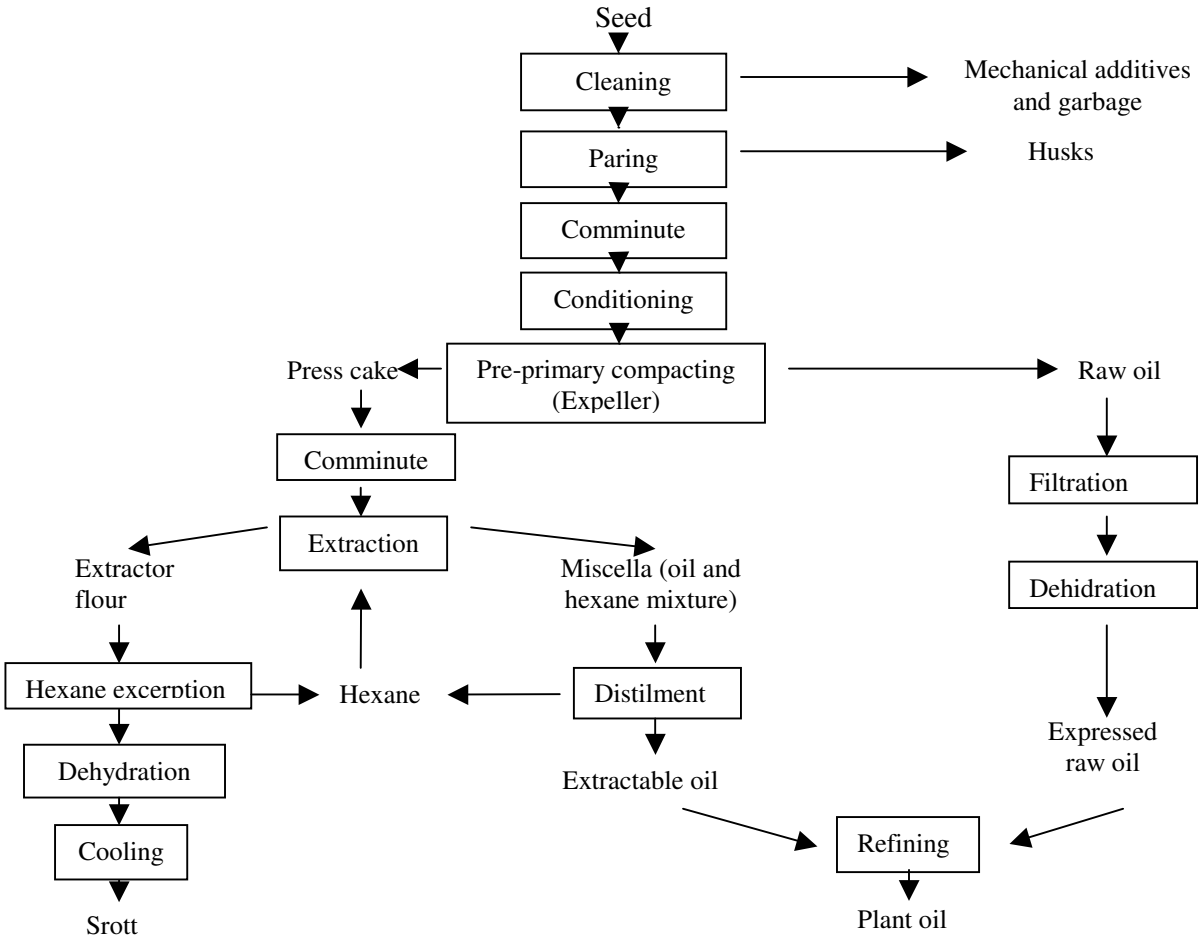

Fig. 1. **Processing oil-seed in (central) industrial oil hall**

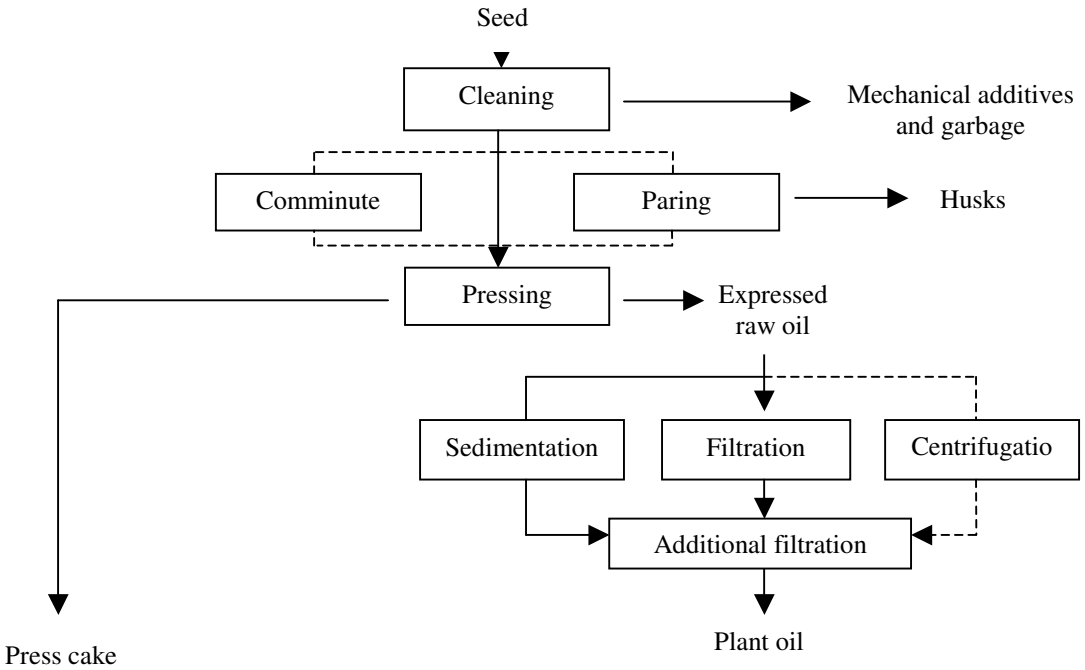

Fig. 2. **Processing oil-seed in (local) small devices**

2. Basic principles of selecting equipment for oil pressing

To provide a better overview of the equipment available and to give explanations and advice on the selection of production equipment for oil-producers several analyses were carried out. The main parameters analysed included the seed reprocessing capacity (kg/h), price (EUR) and power (kW) of the device. With regard to capacity, the analyses suggest that the ratio of the power to the price of the engine is mostly close to the linear relationship (Fig. 3). The variation in power and price (Fig. 4) is likely to reflect the quality of the equipment. Thus, the results of the analysis support the argument that in terms of price it does not make a significant difference whether – to buy one high-power press or two of lower-power.

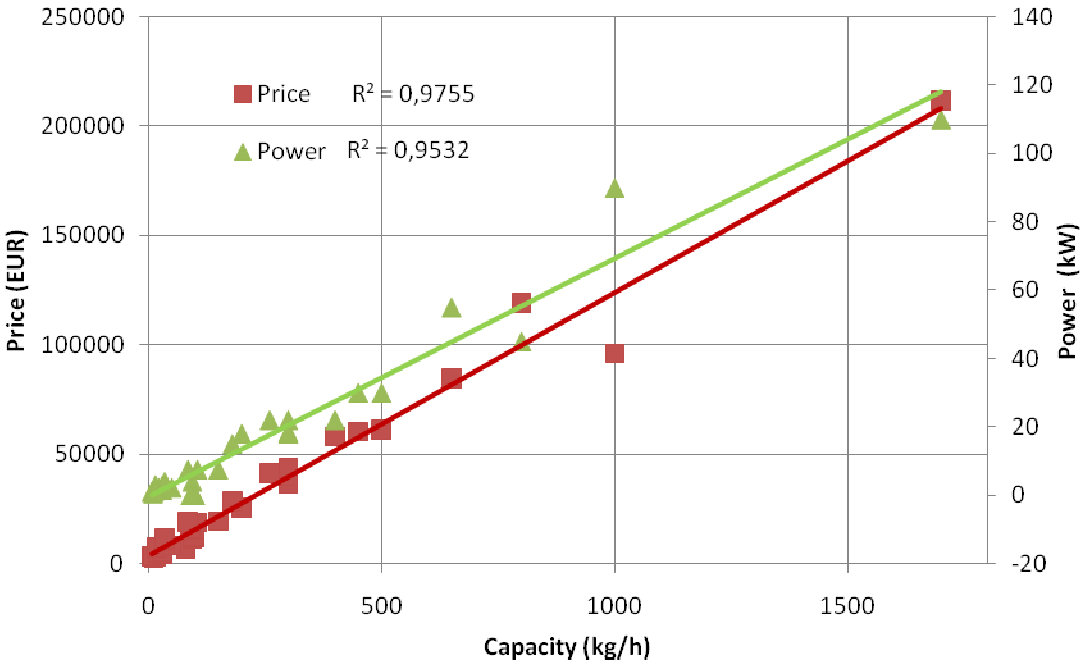

Fig. 3. **Interconnection of oil-pressing equipment power and price considering capacity**

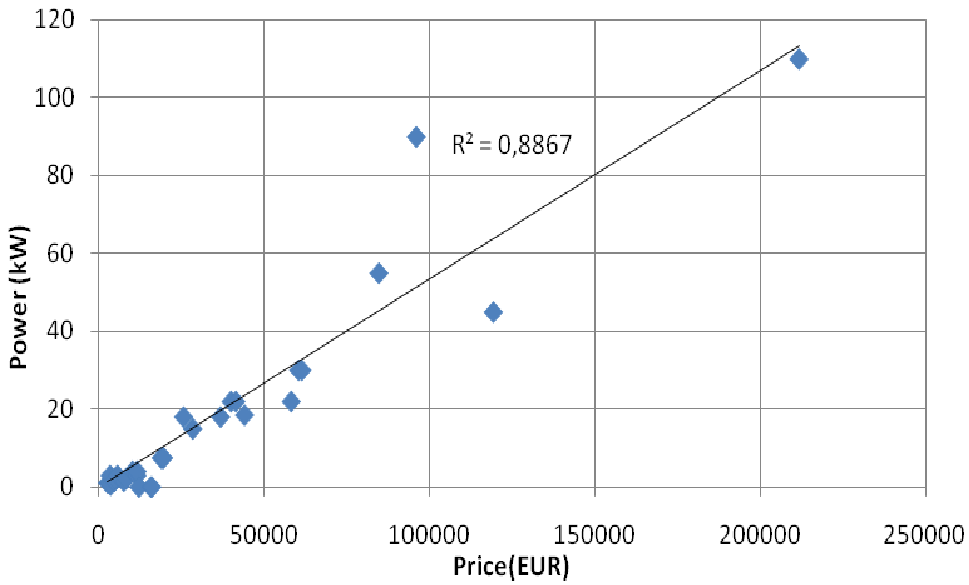

Fig. 4. **Interconnection of oil-pressing equipment power and price**

Based on the production technologies and equipment examined in this study, it is recommended by the author to select the oil press from among the commonly used press types. The press types commonly used in Germany have the capacity of up to *Pp* = 50 kg of seed per hour (local production, Fig. 5). The same trend line can be observed in the analysis of the EU oil-press producers (Fig. 6)

showing the percentage of the oil-pressing equipment on the basis of seed reprocessing. The recommended test equipment should have lower capacity up to *Pp* = 10 kg seed per hour (Heizopresse S1, Farmet UNO). When full-scale oil processing is intended, one has to take into account the fact that a constant sedimentation process requires considerably more space and higher expenditure. More information can be found in [3, 4].

Selection of production technology for small-scale industry (test equipment) should be based on the need for finished products, or in this case, the required quantity of finished oil (litres, tons), depending on the machinery and potential use of rape-cake as forage. Production of oil to be sold as motor fuel requires major investments, standards, accounting, sales permits, etc. on state level, which is not profitable for small-scale production and which is not the purpose of this study.

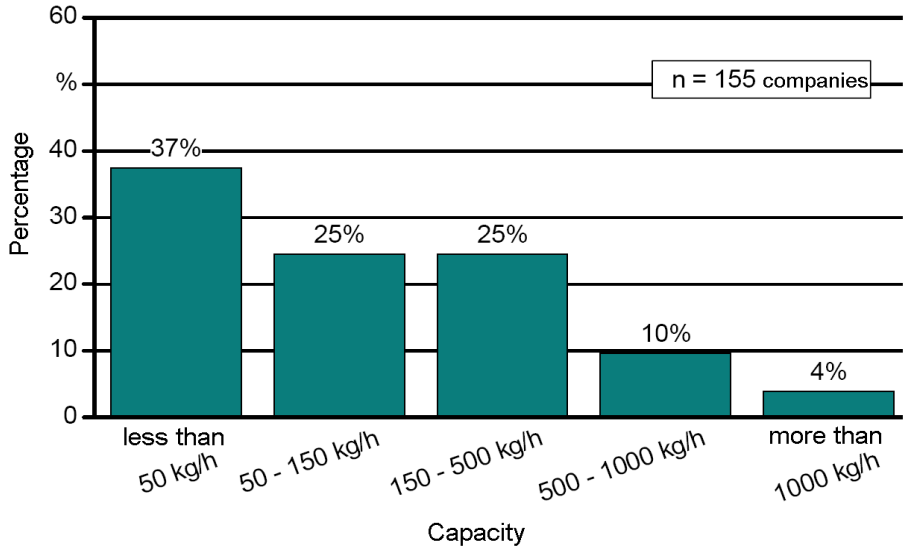

Fig. 5. **The percentage of oil-pressing *companies* on the basis of seed reprocessing**

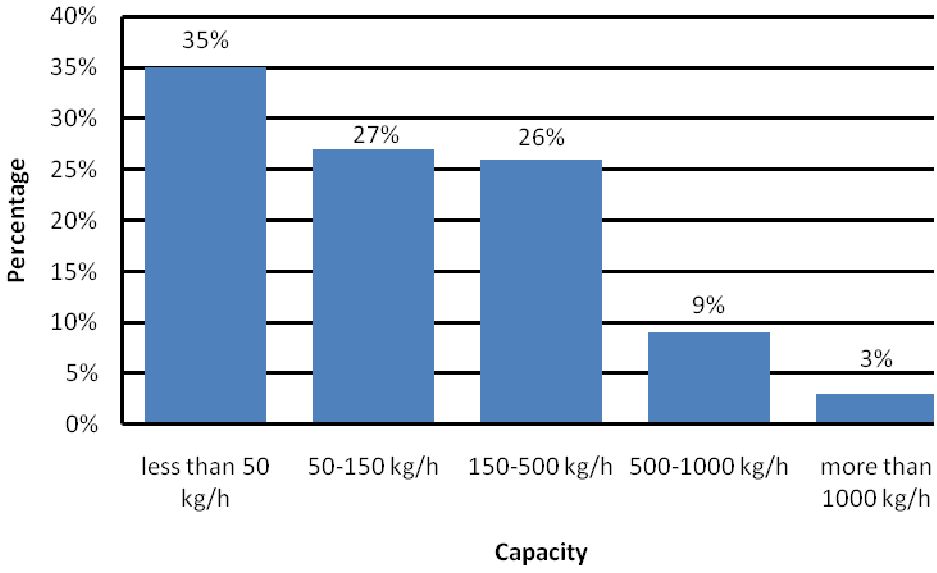

Fig. 6. **The percentage of oil-pressing *equipment on* the basis of seed reprocessing capacity (EU)**

Considering that rape-seed cake accounts for 2/3 of the total production, the selection of the production technology (devices) requires pre-planned composition of forage. The chemical composition (protein, fat, fibre, etc.) and nutritional value (MJ/kg) of the cake depends on the type of pressing (heat-treated or cold-pressed). First and foremost the production should be based on particular needs, thus ensuring circulation of raw material.

3. Press types

The extrusion press is one of the most crucial elements of the production equipment. The screw-type extrusion press is commonly used in case of pressing oil from seeds. Extrusion presses are subdivided based on the construction of the sieve or strainer.

Significant differences of extrusion presses consist in the construction of strainer, where the screw is rotating. In case of an extrusion press with a perforated strainer round holes are made in the cylinder. Press jets are located near the press head, giving a cylindrical form to the pressed cake (pellet). The extrusion press with a rod strainer as well as the extrusion press with a washer strainer has rods or washers with parallel placement at set distances. Oil is separating through the outlets in between the rod strainers or washers. The pressed cake is expelled from behind of the extrusion press as small plates or pellets (if a pellet device is attached). In case of smaller production capacity (average performance up to 75 kg rape-seed per hour) extrusion presses with a perforated strainer are usually used. In case of larger production capacity (average performance up to 3000 kg rape-seed per hour) extrusion presses with a rod strainer and washer strainer are preferred. The presses were analysed in terms of the construction of strainers (Fig. 7). [2-4]

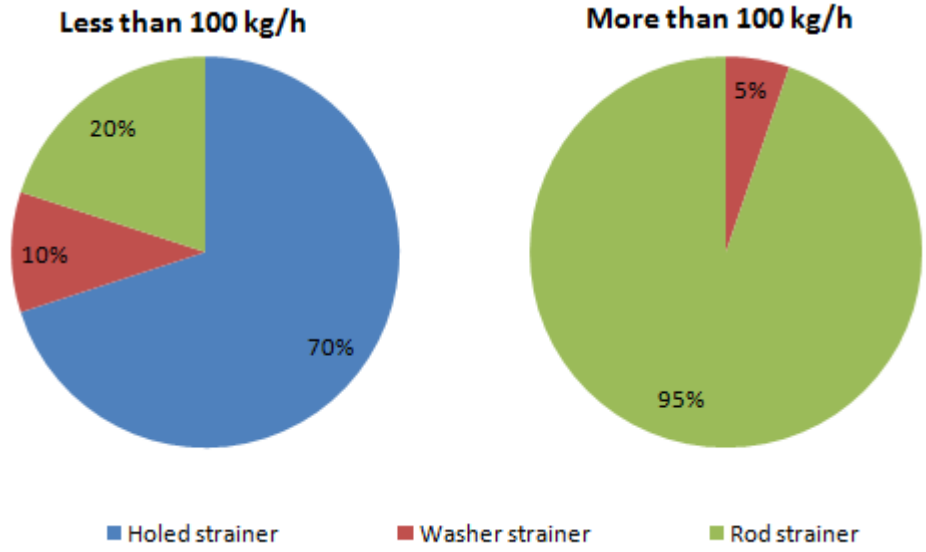

Fig. 7. **The percentage of oil-pressing equipment according to strainer constructions**

Results and discussion

This study revealed that cold-pressing is the best pressing method in order to achieve standard oil properties and the best recommended press type is the extrusion press with a perforated strainer. The reason for that is major increase in phosphorus content in crude oil after increasing the pressing temperature in case of heat-treated processing. However, the information and data on the chemical composition of cold-pressed and heat-treated rape-seed cakes are rather inaccurate and inconsistent, because the content of chemical substances is affected by various factors such as: seed variety, weather conditions, agro technical conditions, etc. Production of rape-seed cake does not have established selection of equipment, because the production should be based on required chemical composition of forage for different animals [5]. The protein and energy content are basic indicators for describing rape-seed cakes produced using various production technologies. While heat-treated pressing (at temperature over 80 ˚C) results in rape-seed cake which has higher protein content and better protein degradation and is therefore best suited for dairy cows, cold-pressing provides rape-seed cake with higher energy content which is suitable for beef breed cows.

Conclusion

Using vegetable oil rather than conventional diesel oil as fuel is a more sustainable option for farmers. Selection of equipment for small-scale - and semi-industrial vegetable oil production has to be based on the price-quality ratio. According to the analysis conducted the most common oil-pressing

devices have the capacity of less than 50 kg of seed per hour and these are the presses that are hereby recommended for use on farms. The analysis has revealed that although there is a wide range of equipment available the data on the pressing results and the reliability of presses are largely missing as the data on how oil affects the reliability of the engine are also missing.

References

1. Biomassi ja bioenergia kasutamise ja edendamise arengukava aastateks 2007-2013, Eesti Põllumajandusministeerium. 3. k: [online] [viewed 8.04.2008]. Available: http://www.agri.ee/public/juurkataloog/BIOENERGEETIKA/bioenergia.pdf
2. Remmele E., Handbuch. Herstellung von Rapsölkraftstoff in dezentralen Ölgewinnungsanlagen, Nova-Institut GmbH, 2007. 83. S: [online] [viewed 15.03.2008]. Available: http://www.bio-energie.de/index.php?id=1205&idtitel=300&idkat=1600&pflanzen=0&verarbeitung=0&gruppen=0&titelsuche=
3. Ferchau E., Equipment for decentralised cold pressing of oil seeds, Folkecenter for Reneweible Energy, Hurup Thy, Danmark, 2000. 64. p: [online] [viewed 08.04.2008]. Available: http://www.folkecenter.dk/plant-oil/efdcpos_ef.pdf
4. Uhl A., Haas R., Remmel E., Befragung von Beitreiben dezentraler Ölsaatenverarbeitungsanlagen, Union zur Förderung von Oel- und Proteinpflansen e. V. Straubing 2007. 55. S: [online] [viewed 10.03.2008]. Available: http://www.tfz.bayern.de/sonstiges/15951/15_berfragung_oelmuehlen.pdf
5. Kass M., Õli pressimise tehnoloogia mõju rapsikoogi proteiini kvaliteedile veiste söötmisel. Eesti aaülikool, Tartu, 2006. 84. lk.