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ECONOMIC AND ENVIRONMENTAL ASPECTS OF INTRODUCING THE USE OF BIODIESEL IN THE HOSPITALITY AND TOURISM BUSINESS OF RURAL ISTRIA

This paper looks on possibility of induction biodiesel fuel in tourism business. According to that, authors research economical and ecological impacts of biodiesel fuel on tourism business and environmental protection. In work, authors give answers about general characteristics of biodiesel fuel, and make comparison with classic diesel fuel. Researching issue are also production process and prices and what kind of effects brings induction of biodiesel fuel on economy of tourism and ecology. From that point of view, authors set up hypothesis that induction of biodiesel fuel in tourism business can obtain increasing in economical view and bring environmental protection of tourist destination. In paper are used methods for researching social, economical and ecological impacts of biodiesel fuel on tourism business development.

Key words: biodiesel, tourism business, rural area, tourism, offer, ecology

INTRODUCTION

Biodiesel is a renewable and biodegradable fuel produced from vegetable oils, animal fat and recycled waste vegetable oils. The idea of using vegetable oils to fuel internal combustion engines is linked to Rudolf Diesel, inventor of the diesel motor. At the 1900 World Fair in Paris, Diesel demonstrated his diesel motor, which was run on biodiesel produced from peanut oil. The idea, however, was abandoned due to low petroleum prices.

Today, the use of biofuels has become a live issue because of petroleum shortages and growing environmental pollution as a result of the emission of harmful fumes from vehicles. With its Directive 2003/30/EC, the European Union has committed its members to secure a minimum 2% share of biofuels and other renewable fuels in transportation by 31 December 2005, and 5.75%, by 31 December 2010. The upward trend in the consumption and prices of mineral diesel due to decreasing sources of crude oil is driving a turn toward fuel alternatives. European regulations stipulate that by 2020 EU member states must substitute 20% of fossil fuels in transportation with biofuels such as biodiesel, bioethanol, biogas and biohydrogen.

In Croatia, the government provides support for the production of biodiesel fuel within the National Energy Program BIOEN. The consumption of diesel fuel in Croatia is continuously growing, especially in transportation and, in particular, in city transportation. For example, in 1995 in Croatia, biodiesel consumption amounted to 711.1 thousand tons, and in 2000, it was up to 892.6 thousand tons.[1]. In 2006, consumption was estimated at about 1100.6 thousand tons of biodiesel, of which 50 thousand tons in Istria.[2].

The consumption of biodiesel is greatest today in transportation; its use, however, is possible in other branches, such as farming, construction, hospitality, tourism, etc. This paper will prove the hypothesis that biodiesel can be used as a fuel alternative and energy source alternative in hospitality and tourism businesses, in which it can help to improve economic efficiency and enhance the environmental protection of tourism destinations. Research also demonstrates biodiesel to be a less expensive, energy-efficient and environment-friendly alternative to mineral diesel.

This paper provides a general description of biodiesel, its production, properties and its use. Its environmental standards are also presented, that is, its impact on keeping the environment clean and healthy.

Finally, based on the major results of research, the paper confirms the hypothesis that biodiesel is a good motor fuel alternative and energy source alternative to heating oil in the hospitality and tourism business. It is a less expensive, energy-efficient and environment-friendly alternative to mineral diesel.

2. ON BIODIESEL AND ITS PRODUCTION

Biodiesel is a fuel produced through the esterification of vegetable oil, animal fat, recycled and other oils using methanol. Most commonly, it is produced from rapeseed oil, although other types of oil from oil plants such as soybean, sunflower, palm, etc. can be used, as well as recycled waste vegetable oil. In chemical terms, biodiesel is described as a mixture of mono-alcohol esters that are, through the esterification of raw vegetable oils in reaction with methanol and in the presence of a catalyst, transformed into fatty acid esters with glycerine, soap and water resulting as by-products. Biodiesel belongs to the group of derivates of medium long-chain (C16-C18) fatty acids, and, as such, it demonstrates a structural similarity to cetane molecules, the basic component of mineral diesel fuel. Biodiesel is the commercial name for methyl ester. Its production process is based on the reaction of higher unsaturated fatty acids and alcohol (most often, methanol – CH_3OH) in the presence of alkaline catalysts (NaOH or KOH). This process is known as **transesterification** (alcoholysis – solvolysis using alcohol), and its by-product is glycerol.

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[1] Kamenski, M: Boidizel, Energetika, 4/2001 p. 45.
[2] Author's estimation.

2.1. Biodiesel production procedure

The technological process of biodiesel production is based on transesterification in which vegetable oils and methanol undergo a chemical reaction in the presence of sodium hydroxide as a catalyst. The chemical procedure of transforming methyl alcohol into triglyceride is fairly simple, and the reaction begins to evolve at room temperature. This procedure takes place at a temperature slightly lower than the boiling point of methanol and at atmospheric pressure. The industrial production of biodiesel requires neither high temperatures nor high pressure. The technological process of biodiesel production is divided into four sections. These are:

1. Oil refining
2. Esterification
3. Extraction
4. Drying

In the first section, the properties of oil to be used in biodiesel production are tested. The properties tested include density, acid number, saponification number, nonsaponifiable matter, viscosity, sulphur content, phosphorous content, water content, iodine number, pour point and cloud point. The expected values are determined using the test methods listed in the below table.

Table 1. **Technical specification of rapeseed oil**

Properties	Unit	Expected value		Test method
		Minimum	Maximum	
Density at 20 ^{0}C	Kg/m^3	900	930	EN ISO 3675
Acid number	mgKOH/g		2.0	EN 14214
Saponification value	mgKOH/g	185	200	
Nonsaponifiable matter	%(m/m)		<0.5	ASTMD 1965-87
Viscosity at 40 ^{0}C	mm^2/s	30	42	EN ISO 3104
Sulphur content	mg/kg		10	EN ISO 20846 EN ISO 20884
Phosphorous content	mg/kg		20	EN 14107
Content of mechanical impurities	mg/kg		500	EN 12662
Water content	mg/kg		1000	EN ISO 12937
Iodine number	mgJ$_2$/100 g	105	120	EN 14111
Pour point	^{0}C		- 20	DIN ISO 3015
Cloud point	^{0}C		- 5	DIN ISO 3015

Source: Internal data of the biodiesel plant Modibit d.o.o. in Ozalj

In the second section, (esterification) a chemical reaction takes place between oil and methanol in the presence of a catalyst (NaOH or KOH) in which methyl ester is produced as unpurified biodiesel, with glycerol as a by-product.

The third section (extraction) consists of procedures for purifying biodiesel. Biodiesel is purified of soap and glycerine using demineralised water and citric acid.

In the fourth and last section (drying), vacuum distillation is used to remove water from the biodiesel end product, which should have the following properties:

Table 2. **Technical specification of biodiesel**

Property	Unit	Warranted value		Test method
		Minimum	Maximum	
Ester content	% (m/m)	96.5		EN 14103
Density	Kg/m^3	860	900	EN ISO 3675
Viscosity at 40 ^0C	mm^2/s	3.5	5.0	EN ISO 3104
Flash point	^0C	120		EN ISO 2592
Sulphur content	mg/kg	-	10	EN ISO 20884 EN ISO20846
Carbon residue	% (m/m)	-	0.30	EN ISO 10370
Cetane number		51.0		EN ISO 4264
Ash content	% (m/m)		0.02	ISO 3987
Water content	mg/kg		500	EN ISO 12937
Total mechanical impurities	mg/kg		24	EN 12662
Copper corrosion	rating	1		EN ISO 2160
Acid number	mgKOH/g		0.50	EN 14104
Iodine number	$mgJ_2/100g$		120	EN 14111
Saponification value	mgKOH/g	150	300	EN ISO 3657
Methanol content	% (m/m)		0.20	EN 14110
Phosphorous content	mg/kg		10	EN 14107
Pour point	^0C		- 20	DIN ISO 3016
Filterability	^0C		- 10	EN 116

Source: Internal data of the biodiesel plant Modibit d.o.o. in Ozalj.

2.2. EU biodiesel production

According to an EU Directive, all EU members are obliged to substitute 5.75% of mineral fuel by 2010 and 20%, by 2020. All EU members have accepted this Directive and are complying with it in accordance to their abilities. As a result of this, EU members have produced the following quantities of biodiesel.

Table 3. **Estimated biodiesel production and production capacities in the EU**

Country	Production in '000 tons		Capacities in '000 tons	
	2004	2005	2004	2005
Germany	1035	1669	1903	2681
France	348	492	532	775
Italy	320	396	827	857
Czech Republic	60	133	188	203
Poland	0	100	100	150
Austria	57	85	125	134
Slovakia	15	78	89	89
Spain	13	73	100	224
Denmark	70	71	81	81
Great Britain	9	51	129	445
Slovenia	0	8	17	17
Estonia	0	7	10	20
Latonia	5	7	10	10
Lithuania	0	5	5	8
Greece	0	3	35	75
Malta	0	2	2	3
Belgium	0	1	55	85
Cyprus	0	1	2	2
Portugal	0	1	6	146
Sweden	1.4	1	12	52
Total	1933.4	3184	4228	6069

Izvor: European Biodiesel Board: EU Biodiesel Production Growth Hits Record High in 2005, Bruxelles, 2006.

The data in Table 3 clearly indicate that, in a single year, EU biodiesel production grew from 1.9 million tons in 2004 to almost 3.2 million tons in 2005, or by 65%. The number of biodiesel producing countries doubled in this one-year period, and, in proportion to this, production capacities also grew, reaching upward of 6 million tons. The market share of biodiesel in the EU amounts to 1.5%, which is close to the goal (2%) set out in the Directive.

2.3. Potential for biodiesel production in Croatia

The supply of biodiesel in the territory of Croatia, Istria included, is far from sufficient. Biodiesel production in Croatia is mostly known from foreign markets. The only biodiesel production plant in Croatia is located in Ozalj and has an annual capacity of 20,000 tons. This volume of production is too small to supply the entire domestic market, although raw materials and favourable locations for production do exist.

The most important domestic crops for vegetable oil production are sunflower, soybean and rapeseed. Olive oil is produced in Croatia's maritime regions, while the production and consumption of other types of vegetable oil such as pumpkin seed oil and corn oil are negligible. The total production of rapeseed over the past decade in Croatia has ranged from 11,000 tons to 24,000 tons, and only in 1999 did production reach the pre-war levels of more than 30,000 tons of raw material. In Croatia, on a total sown area of 1,080,000 hectares, rapeseed, sunflower and soybean accounted[3] for 8.7% and 6.9% of crop production in 2003 and 2004, respectively. The composition of land sown in oil crops in Croatia[4] was as follows:

- In 2003, an area of 94,290 hectares consisting of:
  - rapeseed 15,891 hectares - 16.85%
  - soybean 50,286 hectares - 53.33%
  - sunflower 28,113 hectares - 29.82%
- In 2004, an area of 79,811 hectares consisting of:
  - rapeseed 14,299 hectares - 17.52%
  - soybean 37,131 hectares - 46.52%
  - sunflower 28,381 hectares - 35.56%

Oil crops and, in particular, rapeseed can also be cultivated in Istria. The valleys of the Rivers Mirna and Raša are especially promising for this type of production, but other areas show potential as well. Out of a total surface area[5] of 281,900 thousand hectares in Istria, farmland accounts for 171,500 thousand hectares of which 98,600 thousand hectares are cultivated.

In Istria, about 72,900 thousand hectares are uncultivated, and this land could be used for growing oil crops, in particular, rapeseed, for which the conditions in Istria are favourable. These 72,900 thousand hectares could yield up to 72,200 thousand tons of biodiesel which could help meet requirements for biodiesel in Istria.

There are a number of reasons why it would be advantageous to implement the production of this crop in Croatia. First, this production helps towards enhancing the environmental protection of the land. Second, biodiesel production contributes to the production of alternative products to energy sources that are increasingly being depleted. Third, this production will help to improve the structure of businessnes and the economy, and it will create new jobs. Finally, the production and processing of rapeseed will help to improve the earlier levels of farmland usage. If we add to this other activities, such as the collection of waste vegetable oils from households and kitchens of catering facilities, the opportunity for creating new jobs takes on a broader dimension.

3. BIODIESEL – AN ALTERNATIVE TO POWER FUELS AND MOTOR FUELS IN HOSPITALITY AND TOURISM

The properties of biodiesel make it a suitable alternative to power fuel (heating oil) used in the hospitality and tourism industries for heating rooms in hotels and restaurants, and water in bathrooms, swimming pools and kitchens. Also, biodiesel can

[3] Ivanov, D: prezentacija proizvodnje biodizela u RH, Našice, 2006
[4] Ibidem.
[5] Ružić, P.: Ruralna ekonomija Istre, Institut za poljoprivredu i turizam Poreč, Poreč, 2004. p 3.

substitute mineral diesel for fuelling transportation means used in tourism, excursion ships and buses, taxi services for tourists at sea, tourist trains in destinations, etc.

3.1. Biodiesel as a power fuel alternative in the hospitality industry

For the use of biodiesel as a fuel alternative in restaurants and hotels to be cost-efficient, the biodiesel should be produced from *waste vegetable oil* – the raw material generated by the hospitality facilities. By transforming waste vegetable oil from restaurants into biodiesel, two vital criteria are met: environmental protection and the highest possible raw-material utilisation level. An analysis is made on the example of an average restaurant using simple calculation.

A restaurant produces 300 litres of waste vegetable oil per month X 12 months = **3600 litre/year**. For heating, it uses a maximum of **2500 litres** of heating oil. Because one litre of waste oil yields 0.8 litres of biodiesel, the 3600 litres of waste oil in this example will yield **2880 litres of biodiesel**, a quantity that fully meets the restaurant's annual requirements.

It is interesting to note that an Austrian company purchases waste vegetable oil from the McDonald's restaurants in Croatia for the purpose of producing biodiesel. Croatia should follow the lead of this company and begin to tap into its own potential.

3.2. Biodiesel as a fuel alterative to mineral diesel in tourism transportation

The environmental effects of biodiesel should make the strongest case for its use. For a fact, some advanced countries already have a raised awareness in this respect, and their models should be applied as starting positions for Croatia's economy and tourism. Since 1994 in Gratz, Austria, 140,000 public buses are fuelled by biodiesel.[6] The Zagreb public transportation service "ZET" has 105 buses that could run on biodiesel. It should be pointed out that the million and a half litres of waste vegetable oil, collected and exported to Austria every year, could produce enough biodiesel to drive 40 buses for as long as one year. Were the State to become involved in such a project by providing subsidies and were efforts made to organise the collection of waste oil for processing into biodiesel, the needs for fuel in tourism transportation could be met without any disruptions of the natural equilibrium and without causing pollution.

3.3. Economic effects of introducing biodiesel as a fuel alternative in hospitality and tourism

Economic effects are realised through the utilisation of waste materials in creating new raw materials that meet environmental standards. The introduction of biodiesel is of vital importance in making tourism development sustainable, because it helps in maintaining a natural equilibrium. To open large plants for biodiesel products requires large financial resources; however, one solution could be the opening of national parks in which waste vegetable oil from the region would be collected and processed into biodiesel and then used for the needs of the park and te region's tourism

[6] Lider, „ Zamjenska goriva za automobilsku industriju" 26.5.2006

associations. Not only would this solve the problem of waste oil, but it would also create new jobs, reduce operative costs and contribute substantially to environment protection.[7]Such a plant could have a capacity of 9,600 litres per day.

The prices at which biodiesel is sold are not set in advance, but an indication would be the EU prices of biodiesel that are 7% to 15% lower than the prices of mineral diesel depending on a country's tax policy.

Table 4**. Price of biodiesel and mineral diesel at petrol stations in Germany**

Fuel	Price €/litre
Diesel	1.0853
Biodiesel	1.0095
Price difference	0.0758

Izvor: www.ufop.de

In Germany, the price of biodiesel is lower than that of mineral diesel by EUR 0.0758/litre.

3.4. Environmental advantages of biodiesel as a fuel alternative in hospitality and tourism

Environmentally clean production is defined as the "continuous application of comprehensive prevention strategies of environmental protection to production processes, products and services to increase efficiency and reduce risks to people and the environment".[8]

Biodiesel is the first fuel alternative to have a defined, corresponding standard. Numerous national biodiesel standards exist: the Austrian ON C1191, the German DIN 51606, the Italian UNI 10635, the American ASTM PS 121-99 and others. Prior to the adoption of a European standard, the German standard DIN 516060 served as a reference standard for many producers in countries that did not have their own national standards for this area. The most recent European standard, EN 14214, adopted by the European Committee for Standardisation (CEN) has been in use in EU member states since 2003.

[7] www.poslovniforum.hr
[8] Patričić, R.: Biodizel- projektni prijedlog, Vukovar, 2004, p. 2.

Table 5. **Properties of diesel and biodiesel per standards**

Property	**Diesel (EN590)**	**Biodiesel (DIN 51606)**	**Biodiesel (EN 14214)**
Density at 15°C (g/cmł)	0.82-0.86	0.875-0.9	0.86-0.9
Viscosity at 40°C (mm˛/s)	2.0-4.5	3.5-5.0	3.5-5.0
Sulphur (% of mass)	0.2	<0.01	<0.01
Sulphated ash (% of mass)	0.01	<0.03	0.02
Water (mg/kg)	200	<300	<500
Carbon residue (% of mass)	0.3	<0.03	<0.03
Contamination (mg/kg)	-	<20	<24
Copper corrosion 3h/50°C	Class 1	Class 1	Class 1
Cetane number	>45	>49	>51
Methanol (% of mass)	-	<0.3	<0.2
Ester (% of mass)	-	>96.5	>96.5
Monoglycerides (% mass)	-	<0.8	<0.8
Diglycerides (%of mass)	-	<0.4	<0.2
Triglycerides (% of mass)	-	<0.4	<0.4
Free glycerol (% of mass)	-	<0.02	<0.02
Total glycerol (% of mass)	-	<0.25	<0.25
Phosphorous (mg/kg)	-	<10	<10
Alkaline metals Na, K (mg/kg)	-	<5	<5

Source: www.zr-leap.org/dokumenti/Biogoriva.doc

Biodiesel is the first and, at present, the only fuel alternative that has undergone a complete assessment of exhaust emissions and potential health risks according to a program of the Environmental Protection Agency (EPA). This program involves the most rigorous test procedures for fuel certification. Data resulting from this program represent a consummate inventory of the effects of biodiesel on the human environmental and human health.

Research conducted at the University of California (USA) has shown that diesel engines running on pure biodiesel B100 have a substantially lesser emission of fumes and particulate matter (PM). Emission reduction is about 40% in average. A lower emission of fumes and PM is also achieved when using a mixture of conventional diesel fuel and MERU (for B20: PM reduction, 12%; CO reduction, 12%; HC reduction, 20%; NO_x, 2% emission increase).

Similar results have been obtained in US research with regard to reductions of CO (by about 40%) and hydrocarbons (by about 65%). Only emissions of nitrogen oxide (NO_x) demonstrate an increase in the average of 10% in biodiesel-powered diesel motors. This is because MERU molecules contain chemically linked oxygen. However, the problem can be solved using an iridium catalyst that is capable of reducing nitrogen compounds by 13.35% relative to mineral fuel. Also, the emission of polycyclic aromatic hydrocarbons (PAH) is lower by about 80%. By using a mixture of 5% biodiesel with mineral fuel, NO_x emissions drop by 0.67%. In comparison to the latest generation of mineral fuel, the use of biodiesel as a motor fuel reduces the emission of harmful particles – soot emission, the emissions of CO_2 by 35% and SO_x compounds by 8%, as well as the emission of hydrocarbons.

European countries (Germany, France, Great Britain) have also obtained similar research data. A vital property of biodiesel is that it does not contain sulphur and generates considerablly less CO_2 during combustion. In fact, the combustion of one litre of pure biodiesel generates the same amount of CO_2 that rapeseed consumes in its vegetation to produce one kilogram of biodiesel.

Biodiesel is biodegradable and less toxic than a table salt solution. Engines running on biodiesel demonstrate better combustion, and their fumes do not have an unpleasant smell, do not contain toxic substances and contain less solid particles.

From the aspect of environmental impact, the technological process of biodiesel production is environment-friendly and generates no waste material. The process does not involve the discharge of waste matter from the plant, because waste matter does not exist. The outcome of this technological process is biodiesel – the target product and alternative to mineral fuel – and glycerine fuel, a by-product that is transformed by incineration into thermal and electrical energy.

CONCLUSION

This paper investigates the social, economic and environmental impacts of biodiesel production on hospitality and tourism businesses. These impacts are analysed to confirm the hypothesis: Is it possible to introduce the use of biodiesel into hospitality and tourism businesses and would it have a positive impact on their economic and environmental sustainability?

The research in this paper indicates that the introduction of biodiesel into hospitality and tourism businesses in possible. In the hospitality and tourism trade, biodiesel can be used as a fuel alternative to heating oil in hospitality facilities and as an alternative to diesel fuel for running excursion buses, boats, taxis, etc. Being a less expensive fuel and energy source, biodiesel would have a positive effect of the business economics of the hospitality and tourism industry. Furthermore, the excellent ecological properties of biodiesel when used to fuel transportation vehicles or for heating in hospitality and tourism would help to reduce the emission of harmful gases and substances, which would have a positive effect on the environmental protection of a destination. The paper also shows that, in Europe, biodiesel production is increasingly growing, while in Croatia, the first steps in biodiesel production have already been taken and favourable conditions exist for increasing production.

The obtained research results confirm the hypothesis that it is possible to introduce the use of biodiesel into hospitality and tourism businesses and that biodiesel can help towards improving the economic efficiency of a tourism destination and preserving its environment.

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