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# Awareness, use, and perceptions of biodiesel: A comparison of consumers in Belgium and the United States

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*Maggie Jo Pruitt<sup>\*</sup>, Leslie D. Edgar<sup>†</sup>, and Donald M. Johnson<sup>§</sup>*

## ABSTRACT

Belgian ( $N = 61$ ) and American ( $N = 134$ ) fuel consumers were interviewed in the summer of 2012 to determine their awareness, use, and perceptions of biodiesel. Consumers who were aware of biodiesel were asked their perceptions. A significantly ( $P < 0.0001$ ) higher percentage of Belgian consumers (78.7%) reported owning or driving a diesel vehicle compared to American consumers (9.0%). Belgian and American consumers moderately agreed biodiesel is a high-quality fuel. For both Belgian and American consumers, there was no significant association between owning a diesel vehicle and being aware of biodiesel or having purchased biodiesel. Although Belgian and American consumers agreed that using non-food crops for biodiesel is justified, Belgians were significantly less supportive than American consumers of using food crops for biodiesel. Both Belgian and American consumers disagreed with the statement “I would never use biodiesel”, and the two sets of consumers moderately disagreed that diesel engines would not run properly on biodiesel. Belgian and American consumers agreed that global warming is increasing; however, American consumers were more positive about the potential of biodiesel to reduce harmful exhaust emissions and global warming. Belgian consumers moderately agreed and American consumers agreed that biodiesel is better to use because it is made from renewable resources. Belgian and American consumers generally show similar perceptions of biodiesel, with the exception that American consumers were more positive toward the environmental and renewable aspects of biodiesel use. Recommendations for further research include gaining a better understanding of the potential positive influences that impact consumers’ perceptions of biodiesel.

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## **MEET THE STUDENT-AUTHOR**



*Maggie Jo Pruitt*

I am from Bergman, Ark., majoring in Agricultural Education, Communication and Technology with a concentration in Communications. I am also minoring in Agricultural Business. During the spring, 2013 semester, I served as Director of Lectures on the Honors Student Advisory Board. I have served as a Bumpers College Student Ambassador, and am one of 25 nationwide college campus ambassadors for Agriculture Future of America. Currently, I am completing my Honors thesis project on the perception of genetically modified food in Belgium. Last summer, I interned with the Belgian Institute of Agricultural and Fisheries Research (ILVO) in Belgium and will intern with Scotland's Rural College (SRUC) in Edinburgh, Scotland, this summer. My goals are to attend graduate school and possibly enroll in a Ph.D. program, and my career goals are focused on international agricultural policy, trade, and sustainable development. This project was made possible through the guidance and assistance of my academic advisor, Associate Professor Leslie Edgar and by Professor Don Johnson.

## **INTRODUCTION**

Biofuels are derived from non-fossil sources such as biomass, which is the organic matter of plants. Biofuels are required to meet no less than 80% of content volume of biological materials (Uhlenbrook, 2007). Ethanol and biodiesel are the two primary types of liquid biofuels, used in spark-ignition engines (ethanol) and compression-ignition engines (biodiesel). Ethanol is a product of sugar-producing or starch-producing crops by fermentation processes (Naik et al., 2010); biodiesel is currently made primarily by transesterification of vegetable oils, waste grease, or animal fats (Rojey and Monot, 2010). Biodiesel is one of the main alternative fuels traded internationally (REN21, 2012).

Worldwide biodiesel production increased from 17.8 billion liters in 2009 to 21.4 billion liters in 2012, a four-year increase of 20.2%. In 2011, the United States ranked first in biofuel (ethanol and biodiesel) production by country, with a total of 57.4 billion liters produced (REN21, 2012). Of the total, 3.2 billion liters were biodiesel (REN21, 2012). Belgium was the 11th highest biofuel-producing country, totaling 0.8 billion liters (0.4 billion liters of biodiesel; REN21, 2012).

Knowledge of current levels of greenhouse gas emissions and the prediction of a 50% increase in population on Earth by 2050 has reached consumers worldwide. Today, consumers are increasingly more aware of their

purchasing behaviors with regard to the environment (Van de Velde et al., 2009). Biofuels give consumers an opportunity to purchase a transportation fuel that reduces harmful emissions to the environment; however, some consumers question other potential consequences of the use of biofuels. A 2006 survey determined that respondents with strong concerns about the environment felt that renewable fuels could potentially result in higher food costs (Skipper et al., 2009).

The primary purpose of this study was to determine and compare the awareness, use, and perceptions of biodiesel among retail fuel consumers in the U.S. and Belgium. The secondary purpose was to determine if there were significant relationships between awareness, use and perceptions of biodiesel and selected consumer demographic characteristics among American and Belgian fuel consumers.

## **MATERIALS AND METHODS**

The guided interviews, for this study, were conducted at three retail fuel outlets in Northwest Arkansas and two retail fuel outlets in East Flanders, Belgium. In Northwest Arkansas, 134 interviews were gathered during five two-hour intervals during August and September, 2012. In Belgium, 61 surveys were collected in four one-hour periods in July and August, 2012.

Four interviewers, two in Northwest Arkansas and two in East Flanders, Belgium, conducted the interviews with a printed interview guide that was read to participants. The interview guide was developed by the researchers. A script was created to guide the interview, in which the interviewers stated their name, university affiliation, purpose of the study, and possible time duration for the interview, as well as a question to determine if the respondent was willing to be interviewed.

Interview questions were arranged in three sections. Part I consisted of three questions that required a “yes” or “no” response. These questions related to whether the participant drove or owned a diesel vehicle, if the participant had previously heard of biodiesel, and whether or not the participant had previously bought biodiesel or a biodiesel blend. The second part of the interview guide measured the participant’s perceptions of biodiesel in a 13-question series measured on a 5-point Likert-type scale (1 = “strongly disagree” and 5 = “strongly agree”). Part III contained three questions to collect demographic information regarding the participant’s age, gender, and miles driven per week. If a participant responded “no” to question two of Part I (awareness of biodiesel), the interviewer directly progressed to Part III. Respondents who answered “yes” to question two in Part I, previous awareness of biodiesel in the U.S. ( $n = 94$ ) and Belgium ( $n = 50$ ), completed Part II.

Five individuals with expertise in survey methodology ( $n = 2$ ), biofuels research ( $n = 2$ ), and biofuels marketing ( $n = 1$ ) evaluated the interview guide and judged it to possess face and content validity. The instrument was administered twice to seven undergraduate students at a two-week interval with resulting coefficients ( $r$ ) of stability of 1.0, 0.81, and 0.99, respectively. Four undergraduate students indicated no difficulty in understanding the directions or items during trial interviews.

Descriptive, correlational, and inferential statistics were used to meet the study objectives. The 0.05 level of significance was used for all statistical tests.

## **RESULTS AND DISCUSSION**

This study sought to compare the awareness, use, and perceptions of biodiesel among consumers in the U.S. and Belgium. Of the 134 U.S. respondents, only 94 (70.7%) answered that they were aware of biodiesel prior to the interview (Table 1). In Belgium, 51 of 60 (83.3%) respondents were aware of biodiesel prior to the interview. The difference in awareness of biodiesel was not statistically significant ( $P = 0.06$ ).

A significantly ( $P < 0.0001$ ) higher percentage of Belgian consumers (78.7%) reported owning or driving a diesel vehicle compared to American consumers (9.0%;

Table 1). Despite this greater use of diesel vehicles, Belgian (9.8%) consumers were no more likely than American (9.9%) consumers to have purchased biodiesel ( $P = 0.99$ ).

For American consumers there was no significant association between owning a diesel vehicle and being aware of biodiesel ( $\chi^2 = 2.80$ ;  $P = 0.09$ ) or having purchased biodiesel ( $\chi^2 = 0.97$ ;  $P = 0.33$ ). Similarly, there was no significant association for Belgian consumers between owning a diesel vehicle and being aware of biodiesel ( $\chi^2 = 0.02$ ,  $P = 0.89$ ) or having purchased biodiesel ( $\chi^2 = 0.01$ ;  $P = 0.93$ ). This lack of association between owning or driving a diesel vehicle and awareness or (especially) purchase of biodiesel is both counter-intuitive and potentially troublesome for biodiesel producers and marketers.

Belgian ( $M = 3.54$ ) and American ( $M = 3.57$ ) consumers moderately agreed biodiesel is a high-quality fuel (Table 2). Both Belgian and American consumers slightly disagreed that biodiesel use results in increased engine repair and maintenance costs, with means of 2.78 and 2.82, respectively. American consumers ( $M = 2.27$ ) moderately disagreed that biodiesel is available at most fueling locations in the surveyed area, as did Belgian consumers ( $M = 2.22$ ) regarding fueling locations within the surveyed area of Belgium. Both Belgian and American consumers disagreed with the statement “I would never use biodiesel”, with means of 2.06 and 2.12, respectively. American ( $M = 2.51$ ) and Belgian ( $M = 2.46$ ) consumers both moderately disagreed that diesel engines would not run properly on biodiesel.

Although Belgian and American consumers agreed that using non-food crops for biodiesel is justified, Belgians were significantly ( $P < 0.0001$ ) less supportive ( $M = 2.14$ ) than American consumers ( $M = 2.98$ ) of using food crops for biodiesel (Table 2). This is possibly related to the urbanization and decrease in agricultural land use in Flanders, Belgium, where the interviews were conducted (Tempels et al., 2012). Belgian consumers agreed ( $M = 4.30$ ) that the European Union is too dependent on foreign oil sources; similarly, the American consumers agreed ( $M = 4.36$ ) the U.S. is too dependent on foreign oil sources. American consumers slightly agreed ( $M = 3.28$ ) that they would be willing to buy biodiesel even if it cost more than petroleum, while Belgian consumers remained neutral ( $M = 2.94$ ).

Belgian ( $M = 4.02$ ) and American consumers ( $M = 3.98$ ) agreed that global warming is increasing (Table 2). However, American consumers were more positive about the potential of biodiesel to reduce harmful exhaust emissions and global warming. Belgian consumers ( $M = 3.52$ ) moderately agreed and American consumers ( $M = 3.93$ ) agreed that biodiesel is better to use because it is made from renewable resources. Although Belgian

consumers agreed that the global temperature is rising, they have a tendency to be less willing to pay more for biodiesel ( $M = 2.94$ ). Belgian consumers' resistance to purchasing biodiesel does not support their view that the European Union is too dependent on foreign oil sources. These findings strongly support the need for educational efforts to increase biodiesel awareness and use and positively influence perceptions.

Among American consumers, age was the best predictor of attitudes toward biodiesel, with older respondents having less positive attitudes about the fuel quality, environmental, and food security aspects of biodiesel production and use (Table 3). American females were less likely than American males to support the use of food crops to produce biodiesel or agree that it is better to use biodiesel because it is made from renewable resources. However, age and gender were not particularly robust predictors of attitudes toward biodiesel, with the largest correlation ( $r = -0.37$ ) explaining less than 14% of the variance in American consumers' attitudes.

For Belgian consumers, older consumers were less likely to agree that biodiesel was available at most fueling locations but were more likely to agree that biodiesel produced fewer harmful exhaust emissions (Table 3). Belgian female consumers were more likely to agree that using non-food crops to make biodiesel is justified. Again, neither age nor gender was a robust predictor attitudes toward biodiesel, with the largest correlation ( $r = -0.31$ ) explaining less than 10% of the variance in Belgian consumers' attitudes.

Belgian and American consumers generally show similar perceptions of biodiesel, with the exception that American consumers were more positive toward the environmental and renewable aspects of biodiesel use. Recommendations for further research include gaining a better understanding of the potential positive influences that impact consumers' perceptions of biodiesel. Educational campaigns on the positive environmental effects of biodiesel would be beneficial. Research on the awareness of biodiesel should be expanded. Marketing expansion to include advertisement of biodiesel at fueling locations in Belgium and the U.S. may prove beneficial, in an effort to increase knowledge and awareness of specific locations to purchase biodiesel at fuel stations. Finally, efforts should be made to inform both American and Belgian consumers about the performance, environmental, and food security effects of biodiesel production and use.

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**Table 1. American and Belgian consumers' vehicle type, awareness, and purchase of biodiesel.**

Question	U.S.		Belgium		$\chi^2$	P
	n	Yes (%)	n	Yes (%)		
Do you own or drive a diesel vehicle?	134	9.0	61	78.7	95.7	<0.0001
Had you ever previously heard of biodiesel before I mentioned it?	133	70.7	60	83.3	3.5	0.0615
Have you ever purchased biodiesel? <sup>a</sup>	91	9.9	50	9.8	0.0003	0.99

<sup>a</sup> Only respondents aware of biodiesel answered this question.

**Table 2. Comparison of American and Belgian consumer perceptions of renewable and environmental aspects of biodiesel.**

Statement	U.S.		Belgium		t	P
	M <sup>a</sup>	SD	M <sup>a</sup>	SD		
Biodiesel is a high-quality fuel (n = 94, n = 50)	3.57	0.78	3.54	0.50	0.32	0.75
Biodiesel use will increase engine repair or maintenance costs (n = 94, n = 50)	2.82	0.76	2.78	0.58	0.34	0.73
Using non-food crops for biodiesel is justified (n = 94, n = 50)	3.77	0.91	3.62	0.88	0.93	0.35
Using food crops for biodiesel is justified (n = 93, n = 50)	2.98	1.26	2.14	0.73	5.04	<0.0001
The average global temperature is increasing (n = 92, n = 50)	3.98	1.09	4.02	0.68	-0.43	0.67
Biodiesel is available at most fueling locations in my area (n = 94, n = 50)	2.27	0.82	2.22	0.98	0.30	0.76
The U.S. is too dependent on foreign oil sources/The E.U. is too dependent on foreign oil sources (n = 91, n = 50)	4.36	0.77	4.30	0.65	0.49	0.63
Biodiesel produces fewer harmful exhaust emissions than petroleum diesel (n = 94, n = 50)	3.53	0.86	3.06	0.79	3.21	0.0016
Diesel engines will not run properly on biodiesel (n = 86, n = 50)	2.51	0.86	2.46	0.73	0.35	0.72
It is better to use biodiesel because it is made from renewable resources (n = 91, n = 50)	3.93	0.83	3.52	0.73	2.95	0.0037
I would never use biodiesel (n = 93, n = 50)	2.12	1.02	2.06	0.79	0.35	0.73
I believe average global temperature is increasing (n = 92, n = 50)	3.96	1.09	4.02	0.68	-0.43	0.71
Increased use of biodiesel will reduce global warming (n = 93, n = 50)	3.34	0.90	3.02	0.80	2.13	0.03
I would be willing to buy biodiesel even if it cost more than petroleum diesel (n = 93, n = 50)	3.28	1.14	2.94	0.96	1.8	0.07

<sup>a</sup> Based on a 5-point Likert-type scale where 1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; and 5 = strongly agree.

**Table 3. Correlations between consumer perceptions and age and gender by country.**

Statement	U.S.			Belgium		
	<i>n</i>	Age ( <i>r</i> )	Gender <sup>a</sup> ( <i>r</i> )	<i>n</i>	Age ( <i>r</i> )	Gender <sup>a</sup> ( <i>r</i> )
Own or drive a diesel vehicle <sup>b</sup>	134	-0.02	-0.07	61	0.05	0.06
Aware of biodiesel <sup>b</sup>	133	0.05	-0.14	60	-0.11	0.06
Purchased biodiesel <sup>b</sup>	91	0.05	0.08	50	-0.03	0.22
Biodiesel is a high-quality fuel <sup>c</sup>	92	-0.26*	-0.11	50	-0.13	0.23
Biodiesel use will increase engine repair or maintenance costs <sup>c</sup>	92	-0.05	0.14	50	0.05	0.18
Biodiesel is available at most fueling locations in my area <sup>c</sup>	92	0.08	0.07	50	-0.31*	-0.11
Using non-food crops for biodiesel is justified <sup>c</sup>	92	-0.02	0.03	50	0.27	0.29*
The U.S. is too dependent on foreign oil sources/The E.U. is too dependent on foreign oil sources <sup>c</sup>	89	0.04	-0.04	50	-0.01	0.05
Biodiesel produces fewer harmful exhaust emissions than petroleum diesel <sup>c</sup>	92	-0.37***	-0.08	50	0.29*	0.33*
Using food crops for biodiesel is justified <sup>c</sup>	91	-0.33**	-0.25*	50	-0.18	-0.05
Diesel engines will not run properly on biodiesel <sup>c</sup>	85	0.15	0.17	50	0.17	0.08
It is better to use biodiesel because it is made from renewable resources <sup>c</sup>	89	-0.21*	-0.24*	50	-0.17	0.20
I would never use biodiesel <sup>c</sup>	91	0.19	0.10	50	-0.04	-0.06
Increased use of biodiesel will reduce global warming <sup>c</sup>	91	-0.24*	-0.19	50	-0.06	-0.04
I believe average global temperature is increasing <sup>c</sup>	90	0.06	0.14	50	0.03	0.08
I would be willing to buy biodiesel even if it cost more per gallon than petroleum diesel <sup>c</sup>	91	-0.15	0.19	50	-0.08	0.09

<sup>a</sup> Gender coded as 1 = male and 2 = female.

<sup>b</sup> Coded as 0 = no and 1 = yes.

<sup>c</sup> Based on a scale where 1 = strongly disagree and 5 = strongly agree.

\* $P < 0.05$ , \*\* $P < 0.01$ , \*\*\* $P < 0.001$ .