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## Evidence for Competency H

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Running Head: VEGETABLE OIL RESEARCH

# Commercial and Industrial Applications of Vegetable Oil

by

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Abstract

This paper reviews the effectiveness of different research services at offering results for one central query:  what are the different applications of vegetable oil as an alternative source of energy not only in the automobile industry but also in industrial, professional and commercial settings. The research will explore the usability of different research tools such as search engines, directories, and paid or specialized databases. A conclusion is made regarding the best research tool for this type of specialized query.

The depletion of petroleum reserves, increase in energy demands, unpredictability of fossil oil production and increased environmental concerns have highlighted the need to come up with viable alternative and renewable sources of energy. To date many alternatives have been researched and demonstrated but only few have been proven to be practically feasible in terms of availability, economics, public and environmental safety and simplicity of use as the use of vegetable oils**.**

Throughout the paper each resource is thoroughly tested and evaluated with respect to its technical strengths and quality of the information offered. For purposes of organization and presentation, this paper is structured in three main parts: the first one resumes the findings about the query, the second one analyzes the efficacy of free Internet resources in this search, and the third one evaluates the results obtained from paid or private databases. Within each of the two latter parts, the results will be further divided by the service or engine used. At the end a comparison of all results is done.

## Findings

Vegetable oil has many applications in private, industrial and commercial environments. Its most known application is as an engine fuel. However, it can also be used as a surfactant or wetting agent in many commercial applications such as the cosmetics, agricultural spray mixes, and coating industries.

### *Automotive Industry*

In 1895, Rudolph Diesel developed the engine that is named after him (Cyberlipid, n.d.). From the beginning his intention was to run it on a variety of oils, including vegetable oils (Cyberlipid, n.d.). In fact, when he unveiled his invention at the Paris World Exhibition in 1900, he powered the engine with peanut oil (Cyberlipid, n.d.). He envisioned the use of vegetable oils as fuel to become as important as petroleum and coal (Cyberlipid, n.d.). Almost a century later, his prediction has become a feasible feat.

As a fuel for engines, vegetable oil usually undergoes a process prior to be ready for use in an unmodified diesel engine (Northwest Biodiesel, 2006). Said process is geared towards lowering its high viscosity as otherwise it would cling to an engine's moving parts creating clogs (Mello, 2004, September 9). Once it has been processed, biodiesel is created, a fuel physically similar to petroleum diesel but of organic origin (Consumer Energy Council of America [CECA], 2003). The advantage of modifying vegetable oil into biodiesel is that it produces a fuel with very low emissions (Mello, 2004, September 9).

However, diesel engines can also run on Straight Vegetable Oil (SVO) if the oil is heated or mixed with other fuels (Journey to Forever, n.d.). In fact, "when blended with standard transportation diesel, biodiesel helps to extend the energy capacity of the diesel" (CECA, 2003, ¶ 7). Biodiesel can also be used as heating oil in homes (CECA, 2003, ¶ 7). Obviously, using left over vegetable oil from deep fryers, is very advantageous in terms of economic and ecological savings.

Many organizations and governments have implemented measures to utilize biodiesel within their operations especially in these days of soaring oil prices. So far biodiesel has been successfully utilized to power automotive fleets, buildings, home furnaces, and agricultural and industrial machinery.

The significant advantages of biodiesel versus conventional petroleum are clear. Its use can substantially reduce dependence on imported petroleum, increasing agricultural revenue and creating jobs locally (Journey to Forever, n.d.). It is so far the only alternative fuel that can run in an unmodified commercial diesel engine reducing any need for expensive modifications or special engines (Northwest Biodiesel, 2006). Biodiesel's lifecycle production and use create less carbon dioxide and sulfur dioxide emissions, and reduce particulates and carbon monoxide in the air (Northwest Biodiesel, 2006). The fact that it is made from natural organic resources means that it is completely degradable and thus safe to handle and transport unlike petroleum with its higher flash point (Northwest Biodiesel, 2006). If biodiesel spills, it is biodegradable, breaking down four times faster than petroleum or regular diesel fuel (CECA, 2003). Best of all, it can be produced from readily available crops such as canola, corn, cottonseed, soy, mustard seed, and even hemp so it is cheaper to obtain and produce than other fuels (Journey to Forever, n.d.).

As wonderful as it sounds, there are some cons to using biodiesel. It can degrade certain rubber used in fuel hoses and pumps and loosen engine deposits which can clog filters (Mello, 2004, September 9). Also, biodiesel emits higher nitrogen oxide (NOx) emissions than conventional petroleum when used in diesel engines, although not usually in residential heating equipment (CECA, 2003). NOx is the chief contributor to ozone (Mello, 2004, September 9). This undesirable aspect could be resolved by using lower blends of biodiesel and catalytic converters to reduce this gas' emissions (Mello, 2004, September 9). In addition, the storage temperature of biodiesel needs to be controlled. If it is too warm, it could grow mold and it if it too cold it thickens into a solid all of which makes it more difficult to store and transport adding to its processing cost (CECA, 2003).

Finally, as Mello (2004, September 9, Fuel of the Future section, ¶ 2) points out "one of the limiting factors to biodiesel use is its cost, which is about one cent per gallon more expensive than petroleum diesel for every percent added to the (biodiesel) blend." However, if costs decline with the aid of government bills and tax credits, demand will increase.

A second use of vegetable oil within the automotive industry is it application in biodegradable fluids. Agricultural Research Service scientists, from the United States Department of Agriculture, have developed a process that allows any vegetable oil to be converted into a sulfur-containing molecule while still retaining the basic vegetable oil molecular structures (ARS, 2006, April 11). The resulting biodegradable fluid, is resistant to high-fire, has a high viscosity and polarity, and it has excellent anti-wear and anti-friction properties (ARS, 2006, April 11). These properties are essential for industrial applications. Since all raw materials are derived from vegetable oils, this would offer farmers a value added product or new use for their crops too (ARS, 2006, April 11).

*Electrical Industry*

Common vegetable oil has also been used experimentally as a cooling agent in personal computers (Belev, 2005, August 13). Vegetable oils are increasingly being used in the electrical industry as insulators as vegetable oils are non-toxic to the environment, biodegradable if spilled and have high flash and fire points (McShane, May/June, 2002). However, vegetable oils have issues with chemical stability, so they are generally used in systems where they are not exposed to oxygen, and are more expensive than crude oil distillate (McShane, May/June, 2002).

Vegetable oil also finds many applications as an industrial lubricant in extrusion processes. This is a manufacturing process where a material, often in the form of a billet, is pushed or drawn through a die to create long objects of a fixed cross-section. One example of this type of machinery is a pasta machine (McGraw, 2001).

*Food Industry*

By far the widest applications of vegetable oil are in the food industry. One obvious use is in food preparation where low cost, abundance, and health concerns make vegetable oil preferable to animal lards (Murphy, 2004).Animal fats have been scientifically proven to raise cholesterol as they are packed with saturated fats (Murphy, 2004). By switching to vegetable oils such as canola oil, which is virtually trans fat free and the lowest in saturated fat of any vegetable oil, food service companies such as fast food restaurants are effectively lowering the incidence of widespread maladies such as heart disease (Dow AgroSciences, LLC, 2005, January 12). Moreover, the health benefits of consuming vegetable oil such as flaxseed oil which has a high concentration of Omega-3 fatty acids, have long been touted (Mayo Clinic, 2006).

Another use of vegetable oil use is in food packaging where it is used as a preserving and flavor agent in prepared, canned and boxed foods. As such, vegetable oils are used in many processed products, such as mayonnaise, mustard, potato chips, French fries, salad dressing, sandwich spread and canned fish. This is advantageous with regards to low cost and increased food shelf life. However, vegetable oil usually undergoes a hydrogenation process that prevents it from aging fast and therefore rendering food inedible (Heller, 2003). The byproduct of this process is trans fats (Heller, 2003). Because of their high hydrogen content, trans fats are hard to digest, which increases the amount of bad cholesterol in the blood and it can dramatically boost the risk of heart disease (Heller, 2003). Some scientists estimate that the trans fats that lurk in thousands of processed foods, may contribute to over 30,000 premature deaths each year by weakening the immune system, and causing diabetes and heart disease (Heller, 2003). In order to prevent this from happening, alternative preservation processes are being studied and implemented (Heller, 2003).

A final use within this industry pertains to fruit and vegetable coating applications. Historically petroleum waxes have been used to extend the shelf life of these perishables by reducing moisture loss. Utilizing vegetable oil based waxes instead provides a significant advantage. Given the high saponification point of vegetable oil, making wax emulsions is relatively easy reducing the number of surfactants used, which extends the application areas and also provides cost benefits (Marcus Oil & Chemical, 1999).

*Health Industry*

Perhaps the least known use of vegetable oil is in the health industry. A few years ago, a chemical process was patented to convert vegetable oil to a compound that can be used to prepare antibiotics (Cooke, 1997).

The applications of this are exciting. Currently, industrial food preparation processes can potentially expose food to a variety of bacteria that could in turn affect the well being of its animal and human consumers. If certain vegetable oils such as black seed oil can be used to prevent bacteria growth on food, this in turn can make some bacteria caused diseases which in turn can positively influence the economy (Nair, Vasuden, & Venkitanarayanan, 2005).

*Surfactants Industry*

Vegetable oil has also proven useful as a surfactant or wetting agent, a substance capable of reducing the liquid tension of a liquid in which it is dissolved. Surfactants have applications in the cosmetics, adhesives, paints, emulsions, and agricultural industries.

Personal care cosmetic and pharmaceutical formulations contain an array of additives that provide consumer desired performance properties (United Soy Bean Board, 2006, January). Vegetable oils such as olive, soy, and avocado oils give the finished cosmetic products desirable characteristics such as high essential fatty acids content, and dermatological rapid penetration and absorption rates (Cosmetics Design, 2005, December 1). When employed in microemulsions, clear water and oil solutions that have remarkable wetting and degreasing properties, vegetable oil based products can also be used in personal care products such as shampoo, hand lotions, and metal cleaning agents (United Soy Bean Board, 2006, January). In addition, the market has shown significant interest in naturally derived products of vegetable origin that are also biodegradable and low in toxicity (United Soy Bean Board, 2006, January).

In the area of adhesives, it has been discovered that using hydrogenated vegetable oil in the production of adhesives, imparts adhesives with desirable properties such having a sharp melting point and being repulpable (Marcus Oil & Chemical, 1999). Vegetable oil is more readily available than conventional petroleum and hydrogenated vegetable oil based adhesives can be recycled utilizing less expensive techniques.

In the area of paints and emulsions, vegetable oils such as rapeseed and sunflower oils, are currently used in the manufacturing of glossy paints, oil modified alkyl resins and oleoresinous varnishes and are also used in producing printing inks (National Non-Foods Crops Centre, n.d.). Using vegetable oils in printing inks is an attractive proposition in that they are less damaging to the environment, less toxic and easier to remove than traditional mineral and petroleum based inks (National Non-Foods Crops Centre, n.d.). Features such as de-inking are becoming increasingly important, as more paper is recycled (National Non-Foods Crops Centre, n.d.).

In the area of agriculture, vegetable oil can be used as an adjuvant, a chemical that is added to pesticide formulations to enhance or modify the properties of the pesticide or spray mix (University of Massachusetts, 2000). Adjuvants improve mixing, deposition, retention, spreading, dispersion and drift control (University of Massachusetts, 2000). The industry has successfully employed soy based oils, which are biodegradable, have low toxicity, are cost-effective, and are predictable in performance, in pesticide formulations to control caterpillar damage to corn crops (University of Massachusetts, 2000). Some studies have also shown that vegetable oils can be successfully employed as harvest aids by reducing bruising in mechanically collected fruit, reducing rain-induced cracking in some fruits, and increasing fruit size through bloom thinning (Ju & Duan, 2000).

## Research Tools Evaluation

### *Free Internet Resources*

#### *Google (www.google.com).*

Google is the largest search engine with billion pages indexed. An advantage of using this search engine is that it can search large numbers of documents and provide a large number of results (6,170,000 for vegetable oil use). Also, the links provided in the search can be followed to other relevant resources and it also allows for searching the full text of most pages of a website.

Using very simple search syntaxes here yields the best results. Some of those search terms include “vegetable oil applications,” “vegetable oil uses,” and “vegetable oil usage.” Google uses what it calls a popularity engine, ranking its search results based on the degree to which other pages refer or link to a page. Its Page Rank analysis gives greater weight to authoritative sites. Not surprisingly, the most relevant hits are all found within the first and second result pages.

Its search interface is clean and simple, emphasizing function over form. Google always searches for pages that contain all the words in the query, automatically adding the Boolean operator AND between all words. To force Google to search for a certain phrase, I employ the use of quotation marks around the phrase. This yields somewhat accurate results as Google doesn’t permit the use of truncation or proximity operators.

The advanced search feature in Google, does not yield any better results than the basic search. In fact, quite the opposite. Even when using the same terms as before but manipulating some variables such as language, file format, and other filters, the results tend to concentrate more on the actual usage of vegetable oil in different types of cuisine.

Google’s strength its simple to use interface and that its top few results tend to be remarkably accurate.

*Yahoo! Directory (dir.yahoo.com) and Open Directory (www.dmoz.org).*

A subject directory is a database of titles, citations, and websites organized by categories. To navigate the directory, one can use the categories or the search function. Because the directory is organized and cataloged by a person, not a machine, it is difficult to determine which categories have been assigned to my search which can send me in several different directions. I decide to use the search function first.

The Yahoo! Directory is a commercial directory. This means that it focuses on advertising in order to generate profit. This presents a problem when trying to find authoritative resources. In this case, when using a complex search syntax, only six results from sponsors where found and not all of them were relevant. However, the fact that the results show the categories where they are contained, allows me to drill down through the categories directory later on. The search function allows for the use of Boolean operators with the default being AND. Like Google, it does not allow the use of truncation or proximity operators. Overall, this appears to be an unreliable search engine for content evaluation.

Open Directory is the largest and best known non-commercial directory. Open Directory is owned by America Online and has sixteen major topics with more than thousands of categories. Its data serves as the basis for many major search engines such as Google, Lycos, AOL and Netscape. One caveat is that this is an open model directory, where users submit links and websites, and volunteer editors evaluate and compile the information, which means that quality can potentially be sacrificed. For the search to yield several results, search terms should be kept simple. In this case I simply use “vegetable oil” and determine which links to follow. This technique yields about 160 results. A more focused search such as “vegetable oil industrial use” is not as fruitful with only three results that are not relevant to my search.

*Infomine Academic Directory (infomine.ucr.edu).*

My lack of success with the previous directories, prompts me to switch focus to a more specialized resource. Infomine Academic Directory, is a terrific resource organized by the University of California. It is an academic focused subject directory with nine major categories and over 120,000 indexed pages. A user can browse the categories or utilize the basic or advanced search features.

Browsing is often just as useful as searching as the categories are neatly organized and include a plethora of information such as authors, titles, subjects (Library of Congress Subject Headings are used), keywords, and table of contents. One major advantage is the quality of the content that is found here as academic librarians review listings for relevance, currency, and quality.

The search term syntax here needs to maximize the use of Boolean operators, truncation, proximity operators, and limit options, much like Dialog. This allows for very a very precise search with focused results. For example, the search term vegetable n1 oil* AND use* yielded excellent results.

*Paid Database Results*

*Dialog (www.dialog.com).*

Dialog contains a wealth of information within hundreds of databases. In order to narrow the search, I start by using the central index of databases, DIALINDEX.

The first search strategy involves selecting all the databases (SF ALL) and running a simple search statement such as S (VEGETABLE AND OIL) AND USE? This results in thousands of results many of which appear to be irrelevant (e.g. vegetable oil patents). One aspect of searching in Dialog that I like is the fact that it allows the user to refine the search tremendously. Dialog allows for the use of Boolean operators, truncation, proximity search, and limit options.

The second search strategy involves searching by DIALINDEX's SuperCategories. First, I run the same query as before after selecting the Energy SuperCategory (ALLENERGY). This results in a more manageable thirty two files. However, the first four databases are related to patent filings and I am looking for more scientific in-depth information. Within the listed databases is File 103, Energy SciTec which I choose to concentrate on. I begin a search within this file after determining what the search terms should be. To my surprise, from the results obtained, there are only five of thirty five that pertain to my research. So I decide to search within a different category.

The next SuperCategory is Environment (ALLENVIR). Here the search is more fruitful as related to the researched theme and I identify at least fifteen good resources, mostly all articles published in scholarly journals. However, most of them only list abstracts and the full text is not available making extracting and evaluating the information very difficult. Other searches within News did not fare any better yielding similar quality of results.

In general, Dialog is a fair source of information. The search process is tedious and long as it requires more than just a basic knowledge of how searches are executed within it. Moreover, given that Dialog is not a free resource, cherry picking techniques that are usually fruitful in most free Internet resources, are not advisable here as the final research cost can be expensive. In this respect, it is highly advisable to plan out the search strategy prior to logging in. Dialog is not very user friendly and search strategy cannot be easily inferred.

Some databases are better than others and the quality of the resources is good. Dialog research involves creating somewhat elaborate search syntaxes that change with the requirements and built-in vocabulary of each database. The strength of this database is on the quality of the results but not as much on its accessibility or ease of use.

*Lexis Nexis (www.lexisnexis.com).*

I concentrated on utilizing general simple search terms within the major areas of Lexis Nexis. As expected, I obtain better results by searching in the Subject Directory within the Energy & Utilities subject. This category has some subcategories that address the subject for this search. Among these are Biofuels, Renewable Energy, and others.

About 531 news items are found within the Biofuels subcategory. Just by quickly scanning the retrieved news, I gather that renewable fuels are poised to become the choice of power for our homes, cars, and businesses. Further searches within these results with simple terms such as “vegetable oil” and “vegetable oil use” refine the results considerably. Some of the results contain interesting tidbits are found here such as the background of the diesel engine. The numerous results obtained in this search were in stark contrast to the three items retrieved by searching more specific news sources such as Renewable Fuel News, Energy and Utility News Stories, Diesel Fuel News, and Modern Power Systems.

Overall, Lexis Nexis is a good source of information. Good results are found employing simple searches within the News, Subject Directories, and some specific sources. I noticed that I do not have to create elaborated search syntaxes and information is readily available even for a researcher who is inexperienced with the system. However, the quality of the information is not as thorough as expected especially as it related to the different applications of vegetable oil. The strength of this database is on its ready availability of data only not much on its quality.

On a different note, I notice that about ninety percent of the information is repeated within the Subject Directories. For example, there is not a significant difference of results when searches are conducted under the Biofuels subcategory and the Renewable Energy one; in many cases the same news articles are indexed. This leads me to believe that although there is overlapping of results, Lexis Nexis probably tries to improve on searches by allowing the user to narrow and search within the area of most comfort and knowledge for him or her.

*Academic Search Premier (www.epnet.com).*

In Dialog, the full text of some interesting results is not listed. This prompts me to try and find the complete article through a different paid resource such as Academic Search Premier, accessed through the San Jose State King Library website.

I am able to obtain full text copies of all the articles previously found in Dialog by using the advanced search feature and the titles or author names. I also run searches for simple keywords such as

“Vegetable oil uses” within specific fields such as title, abstract and keywords and this yields comprehensive results all relevant to my research.

By and large, I like the ease of use of databases, such as this one, best. Searches are intuitive and the search format is already specified for the user (e.g. search fields). The interface is very clean and inviting which does not put users off. In addition, this is a good source of information. Results are fewer than using Internet search engines but they are definitely high quality hits. The strength of this database is on its ready availability of data, quality of information and ease of use. As a paid resource, however, not all users may have ready access to it.

## Conclusion

The first steps to conducting a successful search are to determine the What, Where, Which, and How. Determining the unique characteristics of a search in turn determines the search tool to use. Searching tools must be evaluated by their size, relevancy, ease of use, type, advanced search features, and up-to-date content.

Next, a search strategy must be formulated regardless of the database or engine format. It is important here to take time beforehand to learn the intricacies of each search tool, as no two are alike. This can be usually accomplished by consulting the Help or Search Guidelines. The idea is to focus the search as to maximize the quality of the results and save time. A search should be started only after developing the question and the search strategy, and determining the search terms to be used.

Search engines are easier and faster to search but paid databases contain better quality of information. In addition, it takes time to wade through a search engine results for trustworthy information whereas when using Dialog or Lexis Nexis, all the results obtained come from peer reviewed or trade journals, industry papers, or other publication types, so you know that the information obtained is from reputable sources that have done research as to its veracity prior to publishing it.

My personal recommendation is to start out by using a few search engines since they tend to be updated often. In a short amount of time the researcher will know if the Internet contains any valuable information. This dictates what my next steps are whether it is to continue utilizing search engines or move on to another resource. If search engines offer broad results, then using a subject directory to narrow the search is a good idea.

In this case, a quick search in Google first allows me to determine that in the subject of "commercial and industrial uses of vegetable oil," there is a lot of information and there are, indeed, many uses of vegetable oil in both settings. The quality of the results, in turn, makes me realize that I probably need a more technical resource. For this search then I turn to Infomine Academic Directory, Dialog and Lexis Nexis which provide outstanding results.

In conclusion, there are a myriad of search resources available to us but only a few that truly serve our research purposes. The strength and quality of the research is then ultimately dictated by our choice of searching tools.

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