



Canola Breeding for HUMAN HEALTH

by Kaine Korzekwa

The story of canola oil has it all: important plant breeding science, rich history and cultural significance, health benefits, and a dash of Canadian patriotism. And it might be headed for more grocery store shelves and home kitchens as studies show its many dietary benefits and modern plant breeders work to increase those healthy qualities.

Recognized as a crop with a unique breeding and growing history in Canada—quite literally a play on “Canada oil”—some researchers are trying to expand canola production into the southern United States as a beneficial alternative crop as well as break into new health food markets through breeding as the demand for ever healthier oils increases.

Canola oil is the edible form of rapeseed oil. Domesticated several thousand years ago, rapeseed oil was used as fuel for lamps in the Middle Ages and in World War II as marine lubricant. During the 1950s and 1960s in Canada, breeders there developed canola oil, which by definition must contain less than 2% erucic acid in the oil’s fatty acid profile and less than 30 μmol of a suite of chemical com-

pounds known to be toxic in the dry meal.

“It’s a very valuable commodity because of its human health benefits, and the meal is used as livestock feed,” says Michael Stamm, a canola breeder at Kansas State University and a CSSA, ASA, and SSSA member. “The oil comes from the seed, which is approximately 40% oil, about double that of soybeans, for example. The meal has roughly 30–36% protein and can help with milk production in dairy cattle, particularly in the United States where the majority of Canadian canola meal is exported.”

With human consumption deemed safe and under way, the next step has been investigating how beneficial or not the oil is for human health. Carla Taylor, a professor of food and human nutritional sciences at the University of Manitoba and team leader of the Canadian Centre for Agri-food Research in Health and Medicine at St. Boniface Hospital Research Centre, is a leader in this work.

“During the initial development of canola oil, researchers at the University of Manitoba were the first ones to do a clinical trial on canola oil and

to show it’s safe for human consumption,” Taylor explains. “Their research was some of the first to show how canola oil and its omega-3 fatty acid content could be helpful in reducing risk factors for cardiovascular disease.”

Unique Fatty Acid Profile

What distinguishes canola oil is its specific fatty acid profile. It has a high percentage of monounsaturated fatty acids, some polyunsaturated, and very low saturated fatty acids. Of the polyunsaturated fats, it has a significant amount of the omega-3 fatty acid called alpha-linolenic acids (ALA).

Fatty acids are composed of a carbon backbone. If a fatty acid of 18 carbons, for example, has all single bonds joining those carbons, it is a saturated fatty acid and relatively linearly shaped. A single double bond makes it a monounsaturated fatty acid, and anything more than one makes it a polyunsaturated fat. The location of the double bonds also plays a role; double bonds that start three carbons from the end designate

an omega-3 fatty acid, and the same logic applies to omega-6.

Double bonds affect the three-dimensional structure of the fatty acid by making it curve in certain ways to create its conformational structure. The size, shape, and conformation of the fatty acids ultimately impact the effects they have in the body, such as what receptors and signaling molecules they interact with.

"Monounsaturated fats tend to be more neutral in the body, especially compared with saturated fats, which seem to promote more fat storage and may put the body in a more pro-inflammatory state," Taylor explains. "Omega-3 fats are, on the other hand, considered to be anti-inflammatory."

It's this inflammation—the result of a chronic low-level overreaction of the immune system—that seems to be an underlying factor in almost all chronic diseases like cardiovascular disease, cancer, and diabetes. Fats like omega-3 help create a more anti-inflammatory environment in the body and have a positive effect on reducing inflammation.

The benefits of reducing inflammation have been observed in various types of studies. A diet higher in omega-3 fats like those in canola oil has been shown to lower cholesterol, improve the condition of blood vessels, and help reduce body weight.

"Our work has led us to an understanding of 'healthy fat' in the body," she says. "We need fat tissue for insulation and as a store of energy, but we also want fat tissue that is not causing detrimental

pro-inflammatory effects. Providing omega-3 fats in the diet can reduce the size of the fat cells and allow them to produce more of the molecules that reduce inflammation and are cardio-protective."

Most human studies are randomized control trials with carefully chosen inclusion and exclusion criteria. For example, depending on the research question, Taylor and her team recruit men or women of a certain age and also consider if they want healthy individuals, early stages of cardiovascular disease, or people who already have the disease.

The researchers also prepare foods containing canola oil for study participants. In a recent study of Taylor's with overweight individuals, they were provided with two food items per day to incorporate into their usual diet. Another option is providing every meal, which can make it easier to detect an effect as all the food intake is controlled, but it is more costly and time-consuming.

"I strongly believe that diet makes a difference, and I think we also have to provide scientific evidence to show what components of our diets are having positive effects and which aren't," Taylor says. "There is a lot of misin-

and communicated to the public, demand for breeding canola oil with even more healthful benefits will likely increase, Stamm predicts.

"I certainly think demand will increase," he says. "Canola breeders and the food industry are very responsive to market demand, such as the growing interest in healthier food. Canola oil already is healthy and is very versatile, so we should be growing more because it already has its foot in the door. I think it has a bright future."

Balancing Breeding Priorities

As demands change, breeders are exploring niche oils because breeding technologies allow them to go after specific fatty acid profiles. Unless a breeder is exploring an entirely new gene, he or she is in luck because many of the genes that control the oil profiles are known and easily targeted. Getting a new canola cultivar from idea to consumer product can already take more than a decade, so being able to target the right genes is helpful. However, a challenge is the "gene junk" that can often accompany the desired genes and cause unwanted effects that need to be dealt with during the breeding process.

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As these benefits are presented to other scientists at conferences

"It's all about finding the right gene combinations and balancing your priorities," Stamm explains. "Farmers are going to want to maintain

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high yield and oil content, so those have to be priority number one. As a general rule, improving the fatty acid profile can have a negative impact on yield and oil content, so we have to work to improve them. Other times, it might be a very valuable oil, so a decrease in yield is acceptable. As demand changes, we have to weigh these considerations and utilize both conventional and molecular breeding approaches.”

The current types Stamm and other breeders are seeing now and on the horizon are those high in certain types of fatty acids, such as an omega-9, or oleic acid. These oils are attractive to the food industry because they are highly stable—with 70–75% oleic acid—and won’t break down during frying, for example but contain 0 g of harmful trans-fatty acids per serving.

Another newer canola that’s being grown on a limited basis, explains Stamm, is a high omega-3 oil seen as a higher quality health food that was

bred in direct demand for that kind of product. It may grow in popularity and need to be grown in different regions, requiring more breeding and changes in production. He’s also seeing a rising interest in breeding for increased protein in the meal fed to livestock.

In Kansas where Stamm works, canola is an alternative winter crop unlike Canada and similar environments like North Dakota where it is a spring crop. As an alternative winter crop, it can have many benefits like breaking up risks that come with a wheat monoculture and helping to increase subsequent wheat yields while feeding the soil. For him and other breeders and producers, an increased demand comes with more breeding and agronomic research, work with growers’ organizations, the introduction of insurance and new markets to

Dig Deeper

Audio and video from the symposium “Canola Oil and Nutrition,” held at last year’s ASA and CSSA Annual Meeting are available at <https://bit.ly/2kGS4Z7>.

regions, and overall helping farmers be more sustainable and profitable.

For Taylor, who grew up in Canada, canola holds a special place not only in her research interest and on grocery store shelves, but also in her own visions of Canada.

“As canola became more and more popular, it changed the landscape of where I grew up on a farm in a profound way at a particular time of year,” she says. “At the beginning of July, you can see fields of bright yellow when it’s flowering as a testament to what it means to Canada and everyone who grows it.”

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