

CONSUMER AWARENESS AND INTEREST IN
OMEGA-3 FATS AND APPLICATIONS FOR MARKETING CULINARY
CAMELINA OIL

by

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A thesis submitted in partial fulfillment
of the requirements for the degree

of

Master in Science

in

Health and Human Development

MONTANA STATE UNIVERSITY
Bozeman, Montana

April 2007

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April 23, 2007

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GLOSSARY OF TERMS

1. Attitudes are defined as feelings or emotions related to a thing (e.g., dietary fat), including constructs such as interests, concerns, acceptance, and willingness to buy.
2. Behaviors are defined as measurable actions (including a lack thereof), including those that are habitual in nature (e.g., purchasing and consuming food).
3. Beliefs are defined as confidently held perceptions about the world and the self (including self-efficacy, which is situation-specific) as well as associations between various behaviors and outcomes.
4. Hedonic tests are defined as affective types of sensory evaluation in which untrained panels taste and rate items (e.g., foods containing Camelina oil) according to a scale of like/dislike.
5. Intention is defined as conscious planning to engage in a behavior in the future.
6. Knowledge is defined as awareness and understanding (e.g., of types of dietary fat, their research-associated health effects, and food sources).
7. Likert scales are defined as instruments used to measure the extent to which people agree or disagree with statements (e.g., those related to a food sample or theoretical construct being assessed).

ABSTRACT

Camelina sativa is a oilseed-bearing plant that grows in Montana and from which can be extracted oil containing 30-42% alpha-linolenic acid, an essential “omega-3” fatty acid. While researchers have associated certain health benefits with replacing other dietary fatty acids with alpha-linolenic acid and other omega-3 fatty acids, these are scarce in most Americans’ diets. Current consumption levels are likely related to concurrent knowledge, beliefs, attitudes, and other behaviors about omega-3s and fat in general. The purpose of this study was to interview and survey likely targeted consumers to identify potential challenges and opportunities related to these factors for building interest and commitment to use culinary Camelina oil. Researchers intended results to facilitate determination of practical strategies for introducing Montana-produced Camelina oil as a viable commercial food product. Fifty athletes from the Greater Bozeman area ages 14-70 years participated in focus group discussions and sensory evaluation tests. Researchers split participants into 2 groups for each age category (high school, college, and adult), yielding 6 groups of 6-10 participants each. Participants evaluated the sensory characteristics of culinary Camelina as well as Canola, flaxseed, and extra virgin olive oil as straight oils and as components of spreads and vinaigrettes in a series of tests involving affective scales of like or dislike. Following the sensory evaluations, they engaged in focus group discussions concerning omega-3-related knowledge, beliefs, attitudes, behaviors, and potential Camelina marketing approaches. An additional group of 58 adult athletes completed a survey measuring knowledge, beliefs, attitudes, and behaviors related to dietary fat in general and omega-3s in particular. Study participants expressed varied amounts of sensory acceptance as well as apparent preparedness to consume culinary Camelina. Overall, their feedback indicated some likely consumer interest in products containing the oil, particularly if marketed to adults or sold in a vinaigrette.

INTRODUCTION

Background Information

Fat consumption patterns have major consequences for health. Foods such as nuts, seeds, milk, meat, cheese, and oils contain several components, appropriate intakes of which tend to promote positive health outcomes. Components of these foods can include vitamins, fiber, protein, various phytonutrients, and different types of fatty acids (FAs).

The main FA “families,” grouped according to structural similarities, are saturated, monounsaturated, and polyunsaturated (SFAs, MUFAs, and PUFAs, respectively). With some notable exceptions, structurally similar FAs tend to promote similar health effects. Accordingly, several current dietary recommendations involve intake levels of FAs from different families (e.g., obtaining less than 10% of total dietary energy from SFAs). Dietary fat metabolism depends in part on chemical structure. Some FAs are preferentially burned for fuel, incorporated into tissues, or modified to form other molecules. These processes relate to the various health effects associated with absolute and relative intake levels of different FAs.

There are several FA structural variables with metabolic implications. For instance, PUFAs include FAs differing in number of carbon atoms as well as in the number, location, and orientation of carbon-carbon double bonds. Omega-3 FAs (n-3s) and omega-6 FAs (n-6s) differ in the location of the last carbon-carbon double bond on their tails. Meanwhile, n-3s can vary in chain length and extent of desaturation. Fish oil contains the n-3s eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which are longer and more

unsaturated than alpha-linolenic acid (ALA), the only n-3 in non-transgenic plants (see Figure 1).

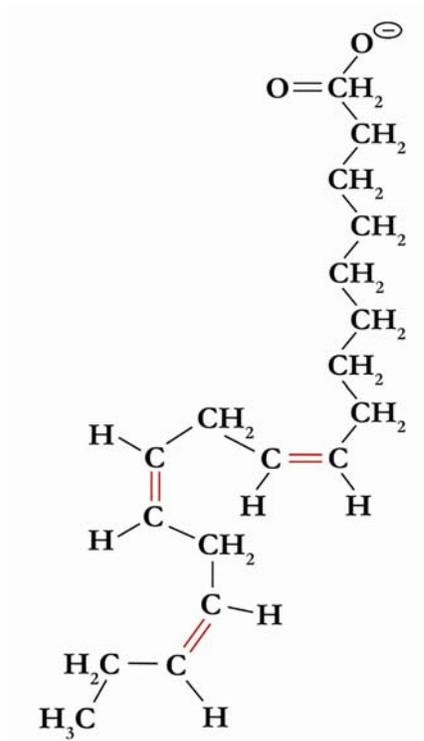


Figure 1. The structure of Alpha-Linolenic Acid (an 18-carbon omega-3 fatty acid with 3 carbon-carbon double bonds, the last at the carbon third nearest the methyl/CH₃ end).

Absolute and relative consumption levels of n-3s have attracted much recent interest among nutritionists as well as food researchers, food and supplement producers, and consumers. One area of interest has been metabolism of ALA to EPA and DHA, which occurs in humans via several elongation and desaturation reactions (see Figure 2). Differing opinions about what dietary and tissue levels of these fatty acids promote optimal long-term health depend in part on interpretation of research into both conversion rates and incompletely understood roles of individual FAs in influencing health.

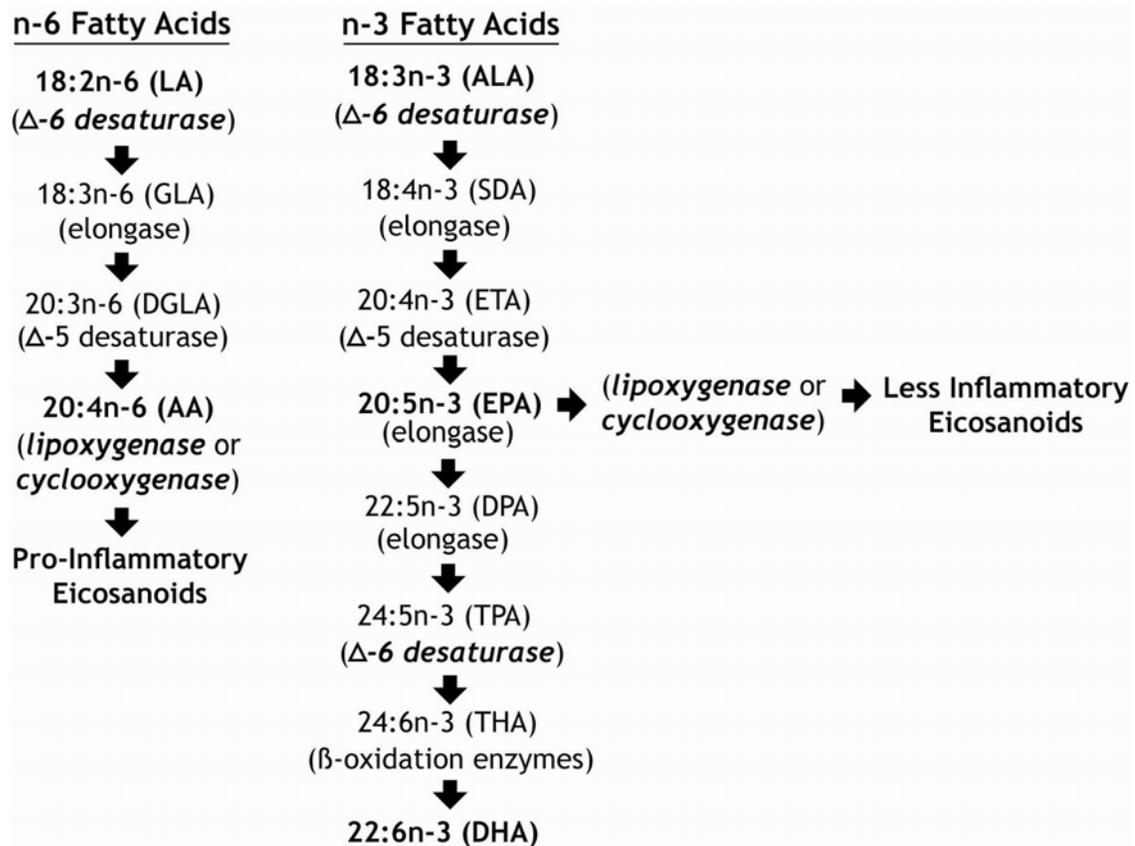


Figure 2. Metabolism of n-3 and n-6 Fatty Acids Following Ingestion. Key rate-limiting enzymes are in bold italics.

The field of nutrition is continuously developing according to emerging knowledge about food components such as specific types of FAs. While links between specific saturated and *trans*-FAs and disease are fairly well established, understandings of the health effects of n-3s and n-6s are still emerging. Based on recent research, there is an apparent range of appropriate intakes of n-3s relative to other types of FAs, particularly n-6s. Both of these PUFAs have important roles in the inflammatory immune response. These relate to shared metabolic pathways such as production of eicosanoids involved in inflammation (see Figure 2). Meanwhile, ALA, EPA, and DHA may all have unique metabolic fates and associated

health effects. Though each may influence specific disease risks in different ways, all three can have moderating effects on inflammation, while n-6s tend to intensify it.

Intake recommendations for specific FAs have followed the arrival of strong evidence linking them to measurable health outcomes. While researchers and nutritionists have yet to reach consensus regarding optimal relative or absolute intakes, most agree on the need for low (e.g., less than 10% of total calories) consumption of SFAs and balanced (e.g., similar) n-6 and n-3 intakes. Unfortunately, a significant disparity persists between current western fat consumption patterns and those recommended by most experts. Many researchers partly blame this disparity for the occurrence of inflammatory diseases in the United States, including arteriosclerosis, asthma, lupus, inflammatory bowel syndrome, certain cancers, and rheumatoid arthritis.

There is potential to alter or perhaps even reverse these unfortunate health outcomes by improving dietary fat intakes (e.g., substituting n-3s for some saturated, *trans*-, or n-6 FAs). As a result, many people in and outside the food and supplement industries are working to increase the availability of high-n-3 foods (see Table 1) and supplements. Meanwhile, others are focused on educating current and potential consumers about the existence and unique nutritional properties of these foods.

The oilseed-bearing plant *Camelina sativa* is a potential contributor of ALA to the American food supply. Fulfilling such potential will likely require that consumers learn about, taste, and choose to integrate Camelina-containing products into their food purchasing and preparation habits. For this to happen, product marketers will likely need to understand possible interrelationships between consumer knowledge, beliefs, attitudes, and

behaviors related to dietary fat and n-3s. They will then need to use these understandings to effectively select target markets and marketing strategies.

Table 1. Foods High in Omega-3 Fatty Acids.

Food	Serving	n-6s	Total n-3s	ALA	EPA	DHA
Flax seeds (ground) ¹	0.25 cup	2.5	9.6	9.6	0.0	0.0
Flaxseed oil	1 Tbsp	1.7	7.3	7.3	0.0	0.0
Camelina oil ²	1 Tbsp	2.3	4.8	4.8	0.0	0.0
Walnuts	0.25 cup	10.8	2.6	2.6	0.0	0.0
Soybeans (roasted)	0.25 cup	4.6	0.6	0.6	0.0	0.0
Tofu, raw	0.5 cup	3.0	0.4	0.4	0.0	0.0
Winter squash (baked, cubed)	1 cup	0.2	0.3	0.3	0.0	0.0
Salmon, wild Atlantic	3 oz	0.5	2.3	0.3	0.4	1.2
Anchovies, European (canned)	3 oz	0.3	1.5	0.0	0.5	0.9
Sardines, Pacific (canned)	3 oz	0.4	1.4	0.2	0.5	0.7
Trout, rainbow	3 oz	0.3	1.2	0.2	0.1	0.4
Tuna, yellowfin	3 oz	0.0	0.3	0.0	0.0	0.2
n-3 Eggs (Gold Circle Farms) ³	1 egg	0.6	0.2	0.0	0.0	0.2

All amounts in grams. All fish baked except for canned anchovies (in oil) and sardines (in tomato sauce). ALA (alpha-linolenic acid), EPA (eicosapentaenoic acid), and DHA (docosahexaenoic acid) are all n-3 (omega-3) fatty acids. Data comes from the USDA Nutrient Data Laboratory¹ except that for Camelina oil² and n-3 Eggs.³

Project Information

This research project was part of a broad effort to facilitate development of value-added products made from Camelina. Funding came from the Montana State University Bio-Based Institute. Researchers explored n-3 and other FA-related knowledge, beliefs, attitudes, and consumption. They did so through focus group interviews, two surveys, and sensory

evaluation tests. Participants were local potential consumers of Camelina oil-containing products. Other ongoing MSU-affiliated Camelina research has recently included an economic feasibility study, test plantings, and chemical analysis of oil samples from Montana-grown Camelina.

Study Purpose and Overview

The purpose of this study was to interview and survey likely target consumers to identify potential challenges and opportunities related to knowledge, beliefs, attitudes, or behaviors for building interest and commitment to use culinary Camelina oil.

Researchers conducted 6 focus groups in April and May of 2006. Fifty athletes from the Bozeman area and MSU participated. Each focus group included 6-10 high school, college, or adult participants. The focus groups also involved question routes with open-ended queries such as “what do you think currently prevents you from including any or more high-n-3 products in your diet?” Additional discussion focused on approaches to educating potential consumers about dietary fat and sources of n-3s such as Camelina oil.

Researchers conducted sensory evaluation testing to gauge potential consumer acceptance of culinary Camelina in three forms. In a series of hedonic tests, participants tasted samples of Camelina-containing products along with similar Camelina-free products and rated them according to like or dislike. The tests included (a) tasting straight oils (Camelina, extra virgin olive, Canola, and flaxseed), (b) dipping wheat bread in the straight oils, (c) spreading a mixture of 2 parts Smart Balance ® 67% Buttery Spread with 1 part either Camelina, extra virgin olive, Canola, or flaxseed oil on wheat bread, and (d) dipping carrots and celery in simple vinaigrettes based on the same oils.

Prior to sensory evaluation or focus group discussions, 18 adult participants completed a survey entitled “Dietary Fat Survey.” This assessed initial knowledge, beliefs, attitudes, and behaviors regarding dietary fat and n-3s in particular. For instance, for an item measuring knowledge levels, respondents selected nutrients they thought were fats from a list containing both fats (e.g., “omega-3s”) and non-fats (e.g., “vitamin E”). An additional 40 adults with minimal knowledge about the research (attendees at a ski club pot luck in October 2006) completed the same survey.

An e-mailed follow-up survey sent to focus group participants served as an additional component of the research. The “Marketing and Consumer Interest Survey” assessed interest levels in specific potential Camelina oil-containing products. These included mayonnaise, spreads, dips, salad dressings, and energy bars. Another item related to food qualities, which, when present, would prompt respondents to pay more than they would for foods without such qualities. This survey also included a list of possible names of culinary Camelina (were it to be marketed in pure form), from which respondents selected their favorites.

Research Objectives

The research project involved four basic objectives. The first was to investigate the fat- and n-3-related knowledge, beliefs, attitudes, and behaviors of potential consumers of Camelina-containing food products by conducting and analyzing data from focus groups involving athletes of various ages from Bozeman perceived as interested in healthy lifestyles and food ingredient quality. The second objective was to gauge these consumers’ sensory acceptance of culinary Camelina oil compared to extra virgin olive, Canola, and flaxseed oil.

The third was to initiate the process of developing effective marketing approaches for Camelina-containing foods based on apparent consumer knowledge gaps and other challenges to building interest and commitment to use such products. The fourth objective was to develop a model for additional and more extensive Camelina research of consumption-related variables involving other potential target consumer groups.

Research Questions

Researchers organized the project based on five primary questions. These were:

1. What are the existing knowledge levels, beliefs, attitudes, and behaviors related to dietary fat and n-3s among a group of health-conscious potential Camelina-containing food consumers (competitive and recreational athletes) in Bozeman, MT?
2. Do any of the existing knowledge levels, beliefs, attitudes, and behaviors related to dietary fat and n-3s indicate challenges or opportunities for building interest and commitment to use culinary Camelina oil?
3. How do consumers compare the taste of culinary Camelina oil to extra virgin olive, Canola, and flaxseed oils, straight and as an ingredient in a vinaigrette and spread?
4. Do any of the taste perceptions of culinary Camelina oil indicate challenges or opportunities for building interest and commitment to use culinary Camelina oil?
5. What might be some strategic approaches for marketing culinary Camelina oil?

Research Hypotheses

To focus the processes of surveying, interviewing, and conducting sensory evaluation, researchers reframed the above questions into a set of actual hypotheses. These were:

1. Knowledge levels, beliefs, attitudes, and behaviors vary by age, gender, and educational background, and are also interrelated.
2. Likely barriers to the commercial viability of culinary Camelina oil include:
 - a. Lack of awareness about Camelina oil,
 - b. Lack of knowledge about how to procure and consume Camelina oil,
 - c. Lack of awareness about potential health benefits associated with n-3 consumption,
 - d. Beliefs that fats are not healthy and that minimal intake is best,
 - e. Perceived invincibility or (conversely) lack of ability to actively shape health,
 - f. Fear of fat,
 - g. Reliance on pre-prepared foods, and
 - h. Lack of habitual consumption of potential Camelina oil-containing foods.
3. Camelina oil has unique sensory characteristics compared to other common culinary oils.
4. Recognizing the unique sensory characteristics of Camelina oil increases interest in consuming it.
5. Marketing strategies that increase perceived benefits or decrease perceived barriers/costs to consuming Camelina oil will promote the commercial success of products containing it.

Study Scope and Limitations

The study was limited in scope and thus, generalizability as well. The participants were predominantly cross-country skiers residing in the Greater Bozeman, Montana area. Their

selection was based on the perception that athletes are relatively interested in purchasing foods based on ingredient quality. In addition, skiers represent a significant component of the Bozeman population. Another study limitation related to the Camelina oil samples used for the sensory evaluation tests. Possible modification of current protocols for pressing Camelina seeds into culinary oil may result in production of Camelina oil with improved or otherwise different sensory characteristics compared to those of the samples used in the sensory evaluation component.

REVIEW OF LITERATURE

Underlying Theory

Food consumer awareness and interest assessment typically involves measuring some combination of knowledge levels, beliefs, attitudes, and dietary behaviors. These appear interrelated and may exert both independent and combined effects on specific dietary behaviors such as intake of fats and oils. Figure 3 (below) illustrates a possible interpretation of their interrelationships. Major constructs from a variety of behavioral psychological theories, including the Health Belief Model, the Theory of Planned Behavior, economics of information, and Social Cognitive Theory, reflect perceptions about the importance of beliefs, attitudes, and other practices (e.g., habits) in influencing behaviors. Researchers and marketers regularly use combinations of these constructs to develop survey, interview, or focus group questions as well as product marketing strategies.

The Health Belief Model (HBM), as the name suggests, centers on the role of beliefs in mediating health-related behaviors. While originally designed for studying or altering single event decision-making (e.g., vaccination),⁴ several of its components can be useful for investigating more habitual dietary practices. The “perceived benefits” of adopting a behavior, when large, tend to promote it.⁴ People who already engage in an activity also typically perceive health-related or other benefits to it. On the other hand, “perceived barriers,” or beliefs about costs incurred in adopting a behavior, tend to oppose and may prevent it.⁵ “Perceived susceptibility” to a given disease, along with its “perceived severity,” can also influence behaviors believed related to it.⁴ In addition, “self-efficacy,” or self-confidence about being able to perform the behavior under specific conditions, tends to play

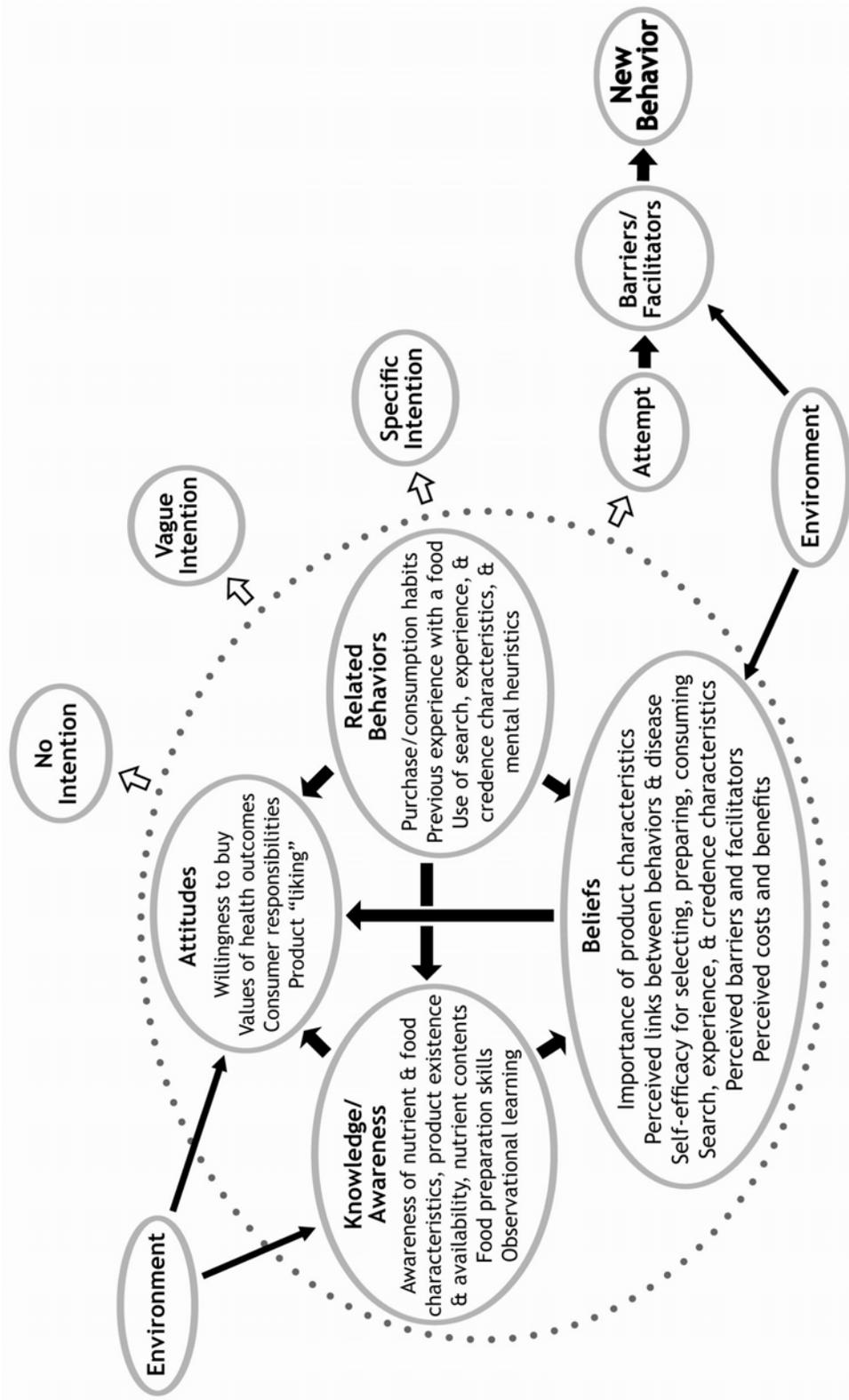


Figure 3. Proposed Underlying Behavioral Change Conceptual Framework and Construct Interrelationships.

an especially important role in influencing habitual behaviors. Determining the relative statuses of these key beliefs can help explain the prevalence of a behavior as well as assist in predicting its future popularity.

The Theory of Planned Behavior (TPB) features attitudes toward a behavior as a major influence on its practice. Specifically, proponents of its use perceive “behavioral beliefs” and “evaluations of behavioral outcomes” to inform attitudes, which in turn influence “behavioral intention.”⁶ “Behavioral beliefs” are defined as associations a person perceives between behaviors and health outcomes, and “evaluations of behavioral outcomes” are the values attached to those outcomes.

Like the HBM, the TPB thus reflects assumptions about the key roles of beliefs. This relatively narrow perception of attitude formation limits the applicability of the TPB in situations involving attitudes such as “liking” of foods. The theory also relies on the sometimes tenuous link between intentions and actual behaviors. These are distinct phenomena that tend to diverge as the temporal gap widens between a given stated intention and the related behavioral event.⁷ In practice, researchers typically compare stated intentions to self-reported or otherwise measured behavior, although some forego this practically significant step.

Despite these limitations, a fair number of researchers of food-related behaviors have employed the TPB with at least partial success. Attitudes, especially about taste, typically appear linked to consumption behaviors (e.g., for soy).⁸ Meanwhile, when measures based on its constructs (only some of which are described above) have inadequately explained or predicted behavior, researchers have included measures for factors like habit.⁹

Some health behavior theories are founded on strong assumptions about the roles of habit and other practices that relate to a given behavior. For instance, according to economics of information theory, consumers may use “search,” “experience,” and “credence” characteristics to inform their purchase decisions.¹⁰ For food, search characteristics such as price are quickly ascertainable prior to purchase.¹¹ Experience characteristics include taste and shelf-life, and determining them may require purchasing a product or else relying on third-party information (e.g., friends’ recommendations). Credence characteristics such as nutritional value are the most difficult to determine, forcing consumers to rely on nutrition expert opinions or regulated health claims on food packages. Accounting for consumer consideration of these characteristics can facilitate more accurate prediction of their product-related behaviors.

Use of “mental heuristics” is another important behavior for understanding consumer decision-making processes. Consumers typically rely on mental shortcuts in order to simplify purchasing decisions.¹² Rather than considering all the available information about a product, they might refer to particularly vivid associations (e.g., a childhood memory involving a food) or information perceived as most important (e.g., brand name or a label indicating local production). This allows them to quickly decide whether or not to make a purchase without having to review possibly expansive amounts of product information (e.g., that available on Nutrition Facts panels, from less vividly recalled experiences, etc.).

The outcome of an attempt to perform a behavior can depend on the presence of actual barriers and facilitators. These are distinct from perceived barriers and facilitators, which fall into the category of beliefs. The Social Cognitive Theory¹³ includes recognition of the importance of both the perceived and real environment.¹⁴ In practice, actual product

availability, price, and dissemination of clear messages linking a product or its contents to a health outcome are likely to inform purchase decisions. Assessing environmental conditions can thus assist researchers and marketers in determining study measures (e.g., survey questions) or marketing strategies (e.g., product labeling).

Knowledge relates to many of the constructs described above, thus warranting inclusion in hypotheses for interactions between behavioral influences (e.g., that depicted in Figure 3). For instance, specific facilitators can include familiarity with a nutrient, knowledge of food preparation techniques, or awareness of a new product's availability. Knowledge is also likely to influence TPB-based "behavioral beliefs."⁶ An individual who is aware of convincing study results linking intake of a food to reduced heart disease might develop a new or stronger belief about the healthiness of the food. Likewise, such a belief shift would constitute an increase in the "perceived benefits" (HBM) for consuming the food.

Explaining, predicting, or influencing consumer behaviors are challenging tasks. Valuable research or effective marketing strategy development depends on success in at least one of these areas. Since several theoretical frameworks have contributed to such success in specific instances, it seems reasonable to recognize the efficacy of integrating "major theories" when trying to "account for all the complexities of behavior change."¹⁵ Depending on the population and behavior in question, specific constructs may have different amounts of applicability. Exploratory research is one means for determining such applicability and assessing possible focal points for subsequent interventions or marketing efforts. In general, an integrative approach allows for examining a range of studies and building on the existing research base without having to rely on unnecessarily constraining methods through strict adherence to a single framework.

Current Knowledge, Beliefs, Attitudes, and Behaviors

Determining the current status of knowledge, beliefs, attitudes, and behaviors related to food, dietary fat, and culinary oils in the United States is a major task. All are subject to change over time and likely differ between populations and individuals according to cultural, physiological, economic, and other factors. This complicates but does not preclude efforts to assess them and identify possible interrelationships with likely relevance to researchers, developers of nutritional interventions, and product marketers.

Knowledge

Several researchers have recently measured knowledge about dietary fat and other potentially relevant topics in a variety of populations, typically via surveys. Few have specifically studied knowledge among athletes, a possible target segment for sale of Camelina oil-containing products. As an exception, Rosenbloom et al provided a self-administered questionnaire to 328 Division I college athletes in Georgia averaging 19 years old and competing in a variety of sports.¹⁶ Despite focusing on issues deemed particularly relevant to sports nutrition, the researchers detected the presence of significant confusion about basic nutritional concepts. For instance, 37% of male and 46% of female respondents were unable to identify carbohydrates and fat as primary energy sources, while 33% of male and 47% of female respondents believed that taking vitamin and mineral supplements increased their energy. Potentially important nutritional knowledge gaps were thus apparent within this athletic population.

Investigation of consumer awareness about the potential health benefits of other recently promoted nutrients may increase researcher and marketer understandings for

developing awareness of healthy oils and n-3 fatty acids. A 2002 American Dietetic Association (ADA) telephone survey of 700 adult heads of household included separate questions about awareness of green tea and berries.¹⁷ The researchers significantly and positively correlated awareness of both green tea and berries to age. In addition, while positively correlating awareness of antioxidants to education level, they found the relationship to be inverse for awareness of berries. This indicates possible complexity and food specificity for the influence of demographic variables on consumer awareness levels.

Dietary fat knowledge is likely to have particular relevance for culinary oil researchers and marketers. Due to limited academic or governmental focus on the subject, industry surveys of consumers, though possibly subject to bias, warrant mention. For instance, based on a 2004 telephone survey of 1000 American adults conducted by an independent research firm, the United Soybean Board reported that less than 10% were able to cite a lack of cholesterol or the presence of PUFAs or MUFAs as potential explanations for soybean oil healthiness compared to certain other fats.¹⁸ Meanwhile, in 2002 the International Food Information Council (IFIC) interviewed 1004 American adults by phone and asked a number of dietary fat-related questions.¹⁹ Their results included the following:

- 80.7% identified animal products like meat and dairy as being common sources of saturated fat,
- 42.0% identified polyunsaturated fats as being more likely a liquid than a solid,
- 68.8% identified saturated fats as being more likely to raise people's blood cholesterol compared to PUFAs,
- 27.6% identified SFAs and PUFAs as containing equal amounts of energy,

- 23.4% were able to identify the recommended maximum saturated fat intake (20 g/d) for an individual consuming a diet with 2000 calories per day,
- 23.1% identified 30% as the current maximum guidelines-recommended percentage of total energy intake from fat,
- 33.8% identified 10% as the current maximum guidelines-recommended percentage of total energy intake from saturated fat,
- 43.4% identified “animal products like meat and dairy” as sources of cholesterol, and
- 24.4% recognized that a gram of fat contains twice as many calories as a gram of protein.

Respondents between the ages of 55 and 64 years old demonstrated the highest overall nutrition awareness levels. The researchers positively correlated awareness with both income and education (through college graduate level) as well.

Two fairly recent studies have included measures of familiarity with n-3s among Americans. First, in a survey administered in 2000 by Harel et al in Rhode Island public schools, ninth-graders demonstrated varying levels of awareness about fat-related dietary recommendations, fat content in foods, and possible links between fat intake and health.²⁰ Of the 1117 students surveyed, 59% were aware of a link between fish consumption and reduced heart disease risk, 29% of a link between n-3s and inflammation, and 25% of a link between n-3s and cancer. In addition, 36% reportedly knew about the recommendation for 2-3 servings per week of fish. Sixty-seven percent also recognized salmon as a source of LCPUFAs, compared to 46% for tuna, 30% for mackerel, and 26% for herring.

For the ADA’s 2002 survey, researchers assessed familiarity in a more direct fashion. Among the 700 adult respondents, 33% reported being “very familiar with” n-3s.¹⁷ This

categorization reflects answers of 4 or 5 on a 1-5 scale of familiarity. Overall, 25% of men and 38% of women reported high familiarity, as did 21% of respondents ages 25-34, 36% of those ages 35-44, 39% of those ages 45-54, 36% of those ages 55-64, and 31% of those ages 65 and greater. This age-based distribution of familiarity was similar to that measured for both antioxidants and soy-based products.

Nutrition knowledge/awareness thus appears incomplete and dependent on a number of factors. These include the popularity or obscurity of foods in question, the complexity of the concepts necessary to understand a nutritional principle, and demographic variables including (but not necessarily limited to) age and sex.

Beliefs

A number of researchers have examined beliefs about food in general and fats in particular that have relevance to development and marketing of culinary Camelina oil. In the 2002 IFIC study, 89% of respondents believed they had at least moderate control over their health, and 71% perceived nutrition as playing a “great role” in health (compared to 63% perceiving this for exercise and 41% for family history).¹⁹ In the USDA’s 1994-1996 Diet and Health Knowledge Survey (DHKS), 66% of adults who considered nutrition to be “very important” (representing 63% of the sample) believed foods could have a big impact on chronic disease risk (e.g., cancer or coronary artery disease).²¹ In contrast, 53% of those who did not consider nutrition to be very important (representing the remaining 37% of the sample) held this view. In a separate measure, IFIC study respondents ranked the top 10 perceived healthiest foods to be broccoli, oranges/orange juice, green leafy vegetables, fish/fish oil/seafood, carrots, garlic, tomatoes, milk, oats/oat bran/oatmeal, and fiber (sic).¹⁹

Eighty percent also associated at least one functional food with reduced risk of a disease.

Meanwhile, 29% of adults in the United Soybean Board survey linked soy consumption with heart health,¹⁸ while 89% of the Rhode Island ninth-graders surveyed by Harel et al believed that eating fish was likely to promote general health.²⁰

As with knowledge levels, beliefs like these appear to vary across demographic groups. Among 1005 adult American respondents to a 1994 telephone survey conducted by Childs et al, women exhibited stronger beliefs than men about the ability of naturally occurring substances in fruits, vegetables, and cereal grains to prevent disease.²² This belief was also reportedly stronger among respondents earning annual incomes in excess of \$50,000 compared to those earning less, for college graduates compared to non-graduates, and for adults ages 35 to 65 years compared to those in younger and older cohorts. The researchers hypothesized that younger consumers may be less concerned about preventative disease issues, while older consumers may be more interested in treatments for existing disease than in prevention. In agreement with these findings and view points, male respondents in the DHKS were reportedly half as likely as women to consider nutrition to be “very important” to health.²¹ On the other hand, respondents ages 55 and up were about twice as likely to hold this view than their younger counterparts, and African American and Hispanic respondents were also twice as likely to feel this way compared to Caucasians. Meanwhile, factors such as household income, education level, nutrition knowledge level, body mass index, and weight status did not appear to influence respondents’ beliefs about the importance of nutrition.

An additional set of consumer beliefs with implications for new product development and marketing relate to food production methods. As part of a three-state study in 2006, King et al administered a survey in Minnesota to measure beliefs about local foods among

500 adult shoppers at farmers markets, supermarkets, and a natural foods store.²³ Perceived better quality or freshness was a reason 75% of respondents considered “most important” or “very important” for buying local food. Other beliefs were that local food incurred lower environmental cost (e.g., due to lower transportation requirements) (held by 35%), helped small business (32%), bolstered the local economy (31%), was easier to trace for safety purposes (14%), or had a better price (10%). In focus groups conducted by Lobb et al involving English adults, participants perceived better taste in “home grown” foods as well as reduced likelihood of producer exploitation.²⁴ In addition, 80% of 819 randomly selected German and French adult phone interviewees agreed with the statement “local origin of organic foods is important”.²⁵ Meanwhile, in the study by King et al, survey respondents had somewhat differing beliefs about the definition of “local food”.²³ For 45% this only included food coming from within a 50-mile radius of Minneapolis-St. Paul, while for 27% this included food grown anywhere in Minnesota or Wisconsin.

Beliefs related to culinary oils are also relevant to commercial Camelina development. Of the respondents to the 2004 United Soybean Board study, 91% considered olive oil to be healthy.¹⁸ In addition, 87% perceived soybean oil as healthy, 82% sunflower and Canola, 79% safflower, and 67% corn. Conversely, 53% considered PUFAs to be unhealthy, and this figure was 49% for MUFAs, 86% for SFAs, and 66% for *trans*-FAs. SFA perceptions actually improved slightly between 2003 and 2004, while TFA perceptions became significantly more negative. That respondents commonly recognized differences in oil and FA family health characteristics bodes well for “healthy” oil marketing efforts.

The available data on n-3-related beliefs is fairly limited. Perhaps most telling is that a reported 48% of respondents in the 2004 United Soybean Board study perceived n-3s as

being healthy.¹⁸ This contrasts with the 30% of 500 American adult respondents (all primary food providers) who associated n-3s with positive health effects in a study published in 2003 by Bech-Larsen et al.²⁷ The 18% difference could relate to population-based differences, distinct questionnaire item wording, or else a possibly significant increase in belief prevalence over time. Meanwhile, Patch et al measured beliefs related to n-3-enriched foods among adult Australians.²⁷ These researchers reported that respondents felt it was important that such foods be commercially available and contain enough n-3s to be beneficial to health. Interestingly, many of those with intentions to consume n-3-enriched foods perceived multiple health benefits from doing so, including certain health outcomes not currently associated (through research) with n-3 consumption.

While making cross-study comparisons is difficult, beliefs about food components, whole foods, and production methods are likely subject to variation within and across populations as well as over time. Key differences exist in the strength, prevalence, and assumptions (e.g., definitions of “local” or “healthy”) underlying these beliefs, and each likely have implications for marketing efforts.

Attitudes

Food- and dietary fat-related attitudes include concerns, interest, acceptance, and willingness to buy/pay more. Researchers typically discuss these constructs in relation to intentions or behaviors (see below). During the 1990s the foremost American nutrition-related concern reportedly was reducing fat intake.²⁸ Much of the available recent research about attitudes thus involves fat-modified foods or reduced-fat diets and has limited applicability to research about culinary oils (which are ~100% fat). Meanwhile, specifically

reducing dietary fat appears less a priority today.²⁸ Nutritional concerns may have shifted but show no signs of disappearing; 90% of respondents on the United Soybean Board study were reportedly “somewhat or very concerned about the nutritional content of food” in 2004.¹⁸

Consumer confusion related to food and health may produce both concern and frustration. More than half of the United Soybean Board study respondents reported being confused by health and nutrition information.¹⁸ This could relate to the apparent 4% drop (from 72 to 68%) in customer willingness to pay more for “healthier food” between 2003 and 2004. Persistent confusion could lead some consumers to quit trying to eat or live in a healthy manner. On the other hand, others are likely to continue looking for answers. Forty percent of the 1994-1996 DHKS respondents strongly agreed with a statement about confusion due to a perceived multitude of nutritional recommendations.²¹ Perhaps demonstrating persistence in the face of prolonged uncertainty, 85% of the 2002 IFIC survey respondents indicated interest in learning more about foods in ways going “beyond basic nutrition.”¹⁹

As with beliefs, consumers often have specific attitudes about food production methods. Some English focus group participants expressed desire to avoid supporting farmers in countries perceived as rivals (e.g., France).²⁴ Likewise, they showed interest in supporting local and national economies rather than those in foreign (e.g., African) countries as well as reducing producer exploitation by buying local foods (which reportedly increased their awareness of supply chain relationships). Agreement of 62% of respondents with the statement “if it was possible, I would only buy food from my region” indicates similar

sentiment among a random sample of surveyed German and French adults.²⁵ Eighty percent of respondents also reported having “more confidence in food of [their] region.”

Recognizing salient consumer attitudes about food is crucial to marketers. Measurement can be difficult based on people’s abilities to recognize them, diversity in measures (e.g., wording of questions designed to assess attitudes), and the complexity of representing them in qualitative or quantitative data. As with knowledge and beliefs, attitudes are also likely subject to numerous variations within and across populations as well as over time.

Behaviors

Consumer behaviors are logically closely tied to product profitability and individual health. Measurement of specific behaviors and trends can involve self-reporting (e.g., on surveys), food disappearance data, and sales figures. Consumption of vegetables and fruits appears to have recently increased, for instance. The FDA reported in 1994 that just 1 in 8 people consumed 5 servings per day of fruits and vegetables (combined), with the mean combined intake likely between 2.5 and 3.5 servings.²⁹ Meanwhile, 35% of the respondents to the IFIC survey reported increasing their fruit and vegetable intake in 2002, compared to 28% apparently doing so in 1998.¹⁹ The ADA reported that 37% and 41% of respondents increased their intake of antioxidants and berries in 2002, respectively, while 23% did so for soy.¹⁷

Functional food consumption may also be increasing. Thirty percent of respondents in a 2002 Dutch survey reported daily use of a single supplement or functional food and 29% consumption of multiple supplements or functional foods.³⁰ Women were most likely to

consume these products, except in the case of Benecol, a margarine containing plant sterols capable of lowering blood cholesterol levels in some individuals.

Despite incomplete data on the subject, local food purchasing behaviors appear limited. For instance, at a large conventional supermarket outside metropolitan Minneapolis-St. Paul, Minnesota, the monthly overall market share of locally-sourced fruits and vegetables varied between 8 and 15% over the course of a year.²³ Meanwhile, very few of the participants in English focus groups discussing local food issues actually purchased a significant amount of their food from local producers.²⁴ Eggs, butter, and fruit were the three most common locally produced foods participants reportedly bought, but only one woman out of 33 adults reported buying at least 50% of food from local producers.

Understanding dietary fat behaviors involves considering absolute and relative intakes of types of fat, both of which appear subject to regular change. The average caloric contribution of all types of fat to American diets in 2004 was about 33%.³¹ SFAs contributed about 11% of total calories in 1999-2000, which was 2% less than the contribution measured between 1971 and 1974. Meanwhile, MUFAs contributed about 12-14% of total calories during the 1990s.³² PUFAs contributed between 5 and 7% of total calories in the 1990s, with 5-6% coming from n-6 sources³³ and 0.4-0.8% from n-3 sources.³⁴ These figures equate to an n-6:n-3 ratio of between 15:1 and 6.25:1. In terms of grams per day (g/d), Ervin et al recently measured mean ALA consumption as 1.2-1.6 g/d for women and 1.3-1.8 g/d for men, while LCPUFA (EPA and DHA) intake varied widely between individuals but on average was 0.04-0.07 g/d.³⁵ In 2002 the Institute of Medicine reported average adult EPA intake as 0.004-0.007 g/d and DHA intake as 0.052-0.093 g/d (combined EPA and DHA intake 0.056-0.1 g/d).³⁴ Finally, *trans*-fats currently appear to contribute 2.6% of total calories,

with 2.1% coming from industrial sources and the rest from ruminant-derived products such as beef and milk.³³

Food disappearance and other data compliment that reported above in providing a picture of modern American dietary fat behaviors. For instance, per capita cooking and salad oil consumption reportedly increased from 15 lbs in 1970 to 29 lbs in 1997.²⁸ Olive and Canola oil together accounted for 16% of all salad and cooking oils in 1997, compared to just 2% in 1985. Along with cooking and salad oil, total added fats (i.e., those not already in foods like eggs, meats, fish, nuts, and dairy) constituted 43% of all fat in the food supply in 1970 and 52% in 1994. This may have reflected increased consumption of fried fast foods, processed foods, or salad dressing. Interestingly, a reported 7% drop in added fat consumption occurred between 1993 and 1997. But while 36% of respondents to the IFIC phone survey reported attempting to reduce dietary fat in 1998, only 23% reported such efforts in 2002.¹⁹ Some consumers may have shifter their focus from total fat intake to fat quality during the 1990s, when fat spreads lower in total fat or higher in PUFAs gained an increase in market share.³⁶

Within these overall consumption patterns, there are apparent differences between specific demographic groups. In a mailed survey involving 2771 American adult respondents from 11 states, Medeiros et al reported that age, body mass index (BMI), and gender all significantly influenced dietary behaviors.³⁷ Older respondents tended to consume less energy as fat while having higher fiber intakes than younger respondents. The researchers also measured an association between higher BMI and “poorer practices” for fat and fiber. In addition, women tended to have better practices than men in these areas.

Recent reported n-3 consumption behaviors indicate a burgeoning enriched food and supplement industry. A study by the research firm Packaged Facts indicated growth of the market for n-3-enhanced foods (i.e., infused with DHA, EPA, or ALA) from \$100 million in 2002 to \$6 billion in 2006.³⁸ The firm reported domination of grain-based enhanced foods (e.g., cereals and bars), which accounted for an estimated 86% of sales, while expecting enhanced dairy products to become increasingly popular. The Gale Group reported similar growth in sales of fish oils and essential fatty acids by chain drug stores (Wal-Mart excluded).³⁹ Between December 2005 and December 2006, such sales reportedly grew 30.5%, reaching \$131.8 million. Firm representatives predicted that demand by “aging baby boomers” would continue to increase and drive further growth in fatty acid supplement sales. Curiously, researchers for the 2002 ADA nutrition trends study reported that while 13% of respondents 65 years and older increased their n-3 intake during 2001, 23% apparently decreased it.¹⁷ On the other hand, around 22% of respondents ages 35-64 reportedly increased consumption, while about 11% decreased it. Overall, the researchers reported 18% of respondents as having increased and 13% as having decreased n-3 consumption during 2001. They further positively correlated consumption with education level, as respondents with post-graduate education experience reportedly consumed the most n-3s.

As a group, Americans consume vast amounts of dietary fat. Precise sources and absolute and relative intakes vary according to demographic and other variables. Apparent recent increases in n-3-containing product sales have not been accompanied by major increases in measured overall n-3 or total fat consumption. Meanwhile, local foods face stiff

competition from those produced elsewhere. There are likely opportunities for much greater sales and consumer intake of n-3-containing and local food products.

Information Sources

Based on the possible links between knowledge (or awareness) and dietary fat behaviors, research about information sources used by consumers is likely salient. According to the United Soybean Board, 83% of adult survey respondents considered the Nutrition Facts Panel when making purchase decisions about packaged foods, while 50% obtained soy health information from magazines or newspapers.¹⁸ Parents reportedly served as nutrition information sources for 58% of surveyed ninth-graders in Rhode Island, while 28% used health classes, 21% care providers, and 21% books.²⁰ Consumers may use different information sources with varied degrees of trust, however. In the IFIC survey 47% of respondents reported trusting health professionals (34% physicians and 21% dietitians/nutritionists), compared to 23% who trusted the media.¹⁹ Meanwhile, ADA survey respondents apparently decreased use of doctors as information sources between 1999 and 2002, resulting in just 12% using doctors in this way in 2002.¹⁷

There is also apparently a growing reliance among consumers on media information sources. In the ADA study reported use of television as respondents' primary source of information increased between 1999 and 2002 by 72%, magazines by 58%, and newspapers by 33%.¹⁷ Radio and internet use both increased as well, particularly among younger respondents. Women were more likely to rely on magazines and books than men, who were likewise more likely to rely on radio. Meanwhile, in a more recent survey of American food shoppers' behaviors in seeking information about "ecolabels," 60% of respondents used

websites, 57% signs next to products, 48% other information located in a store food section, 39% magazines, 37% newspapers, and 35% unspecified local food resources.²³ Website users were most often between 30 and 39 years old, while consumers ages 55 to 64 tended to use magazines less than other age groups. In addition, natural food store shoppers tended to use magazines and local food resources more (and information in store food sections less) than others.

Food labels represent a unique source of nutrition information and are distinguished by their availability on products and temporal proximity to purchasing decisions. While brand or geographic source information is available on some produce items, packaged foods typically contain information about brand, ingredients, and nutrient contents, and possibly nutrient claims as well. Disclosures on packages that are clearly and prominently displayed can potentially provide “relevant information that is directly accessible and encourages the retrieval of other information available in memory.”⁴⁰ Ideally, exposure to disclosures broadens consumers’ cognitive “frame[s] of reference,” reducing their likelihood of making inappropriate generalizations about the product. One federally-required disclosure for most foods is the Nutrition Facts Panel. This standardized description of nutrient contents (e.g., grams of saturated fat), confers to consumers the ability to compare selected content information to nutrient claims.

While the designers of these studies did not often address the ways in which consumers actually processed information about food products, they do provide insights into where such information was obtained. Such understandings can inform initial marketing strategy development, such as by identifying potential information channels likely to be used by specific demographic groups.

Interrelationships Between Knowledge, Beliefs, Attitudes, and Behaviors

Factors Preceding Intention

There appear to be a number of possible interactions between knowledge, beliefs, and attitudes that can occur prior to development of dietary behavioral intentions. Understanding them can foster more efficient research or marketing efforts. First, exposure to information can increase nutritional knowledge and awareness levels. The impact may be cumulative based on “the continual repetition of a message on the most basic common denominator linking diet and health.”⁴¹ Duration of exposure to nutrition information (e.g., research-based links between intake of certain foods and reduced incidence of a chronic disease) appears to more strongly influence the presence and level of awareness of such links than the seriousness of the disease in question.¹⁹ Consumers’ beliefs in the efficacy of given associations also appear to increase with exposure time and awareness level.

This latter finding suggests a relationship between exposure to information and food-related beliefs/perceptions. Awareness-raising campaigns such as the “5-a-Day” Program for fruits and vegetables appear to have recently had (or at least contributed to) such effects, for instance. Researchers for an FDA study of 1004 adult Americans reported that in 1991 just 8% of respondents perceived benefits from fruit and vegetable consumption.²⁹ This figure reportedly jumped to 29% in 1993. Likewise, in 1991 33% believed that one daily serving of fruits and vegetables (combined) was sufficient for supporting long-term health, but just 10% reportedly believed this in 1993. Effects on beliefs may occur in the presence of promotional as well as unfavorable information, as indicated by an apparent 13% increase in negative perceptions of *trans*- fat among consumers between 2003 and 2004.¹⁸

Label information can influence consumers' beliefs in a number of ways as well. In a study involving the primary food providers from 500 families in the United States, Denmark, and Finland, Bech-Larsen et al measured a significant positive effect of package health claims on perceptions of the healthiness of a fat spread as well as other products.²⁶ The magnitude of the effect was greater for products not traditionally perceived as healthy (e.g., spreads) than for others like juice. In a similar study, Andrews et al measured the effects of differently labeled margarine samples on the product perceptions of 365 adult mall shoppers in Boston, Chicago, and Los Angeles.⁴⁰ The researchers found that, when provided information in the form of a health claim, specific claims (e.g., "no cholesterol") had a greater "believability" than general claims (e.g., "healthy"). Demonstrating another effect, Kozup et al found provision of information about *trans*-fat consumption risks to university students to significantly increase perceptions of disease risk for foods with 4 grams of *trans*-fat per serving.⁴²

Levy et al examined the perceptions of 1403 American primary shoppers in relation to exposure to health claims of varied length, content, and presentation style for raisin bran cereal, frozen lasagna, and strawberry yogurt.⁴³ Depending on the product and claim type, the researchers measured positive, negative, and lack of significant belief effects. In some cases content claims proved equally or more effective than health claims, the latter of which refer to both a product and a relationship between diet and disease. They also found that claims were most effective when providing customers with "new" information about a food. Claims for cereal folic acid content and low-fat lasagna thus had more impact than one for calcium in yogurt. Interestingly, after viewing its label, less than 40% of study participants recognized that a product could purportedly benefit a specific population of people when

the product was labeled with a health claim to that effect. In addition, less than 10% could describe *how* a specifically labeled product might affect the specified population's health.

In addition to outcomes like these, consumers appear subject to applying label information in several ways. Levy et al found that in some cases both content and health claims increased perceptions of positive health effects that were explicitly mentioned, implausible, or beyond those mentioned.⁴³ In other words, certain consumers generalized information to include other possible health effects. Other researchers have measured similar "halo effects" of claims (e.g., ones specific to heart health) on beliefs about both related and unrelated attributes.⁴⁴ In other cases, consumers may apply mental heuristics in judging nutrient quality based on one or two characteristics. Garretson et al concluded that such was the case among 383 surveyed adults who appeared to evaluate mock frozen dinners based solely on total fat content.⁴⁵

Attitudes about food (including concerns, willingness to buy, acceptance, and interest) appear related to exposure to specific information. Attitude impressionability may also vary between types of food. For instance, Bech-Larson et reported that attitudes about functional foods appear much more subject to influence compared to those about genetically modified foods.²⁶ Linking exposure to information and attitude, Bower et al found that the extent to which adult female evaluators liked a fat spread depended in part on product labels.³⁶

Exposure to a campaign to increase consumption of local foods in Iowa also appeared to effect consumer attitudes.⁴⁶ As part of an overall Food Education Program, consumers received seasonal recipes and cooking tips, cooking demonstrations, food samples at farmers markets, and handouts on storage and food availability. Follow-up qualitative surveys and

verbal and written feedback indicated “clear increases” in willingness to buy local foods in the future among consumers involved in the program.

Acceptance and willingness to buy a new food are essential for commercial success and are also subject to influence by several factors. Historically, the chief determinants of food acceptability appear to have been price, sensory characteristics, and nutrient content.⁴⁷ Meanwhile, in a study by Patch et al on functional foods, processing method, claim type, enrichment type, and product type all influenced acceptance depending on consumers’ interests in personal health and environmental sustainability.²⁷ For n-3 enriched foods, Bech-Larson et al also measured a significant association between acceptance (described as “utilities”) and consumer awareness of positive health effects associated with n-3 consumption.²⁶

Despite the possible contributions of these many factors, it is probable that liking a product will remain a major determinant of consumption. In a sensory evaluation experiment also involving food labels, researchers provided evaluators with several fat spread samples labeled as either Benecol or Flora (brands).³⁶ The latter received significantly higher taste ratings. Exposure to health claims and nutrient information increased the average amount participants were willing to pay for Benecol, a fat spread designed to help lower blood cholesterol levels. Interestingly, when researchers placed Benecol labels on spread samples that were actually Flora, participants who tasted the samples were reportedly willing to pay 26% more than when they tasted Benecol that was correctly labeled.

The interrelationships between variables preceding intention are complex but worth exploring. People with unfavorable attitudes about food products are not likely to realize any

potential to consume them. On the other hand, effective use of information (e.g., through marketing) to promote positive attitudes is likely to exert favorable effects on consumption.

Intention

Purchase intentions are also subject to multiple influences but theoretically represent greater proximity to action than favorable attitudes alone. Interestingly, Patch et al measured attitude to be the greatest predictor of intention to consume n-3-enriched foods among 129 Australian adults ($r = 0.56$, $p = 0.01$).²⁷ Accordingly, “intenders” and “non-intenders” exhibited significantly different attitudes about the foods. Applying the Theory of Planned Behavior, these researchers also measured a significant effect of “subjective norm” ($r = 0.41$, $p = 0.01$). “Normative beliefs” contributed to the effect of subjective norm, specifically in relation to the perceived interests of family members, friends, doctors, dietitians, and scientists (but not food companies). Intenders and non-intenders also differed in (behavioral) beliefs about n-3-enriched products’ potential to mediate specific health outcomes, although they shared perceptions about the importance of “health parameters.” Meanwhile, age, income, education level, perceived behavioral control, and control beliefs did not differ between the groups. Overall the TPB model accounted for 72.4% of the variance of intentions ($p < 0.001$).

Other researchers have similarly applied the Theory of Planned Behavior in examining intention to consume a variety of foods including soy products,⁸ as well as meats, milk, cheese, and olive oil.⁹ In the case of soy consumption among 204 women surveyed in Chicago, Illinois, Rah et al measured significant correlations (all $p < 0.01$) between behavioral intention and behavioral attitudes ($r = 0.57$), subjective norms (based on

perceived concerns of healthcare providers) ($r = 0.37$), and perceived behavioral control ($r = 0.33$).⁸ Saba et al also measured a positive and significant correlation between attitude and intention to consume meats, milk, cheese, and olive oil among 860 randomly-selected Italians.⁹ That Tuorila et al generated similar findings suggests typically strong links between food attitudes and intentions.⁴⁹ Among University of California-Davis female university students and employees, these researchers concluded “liking” (an attitude) to be the “dominant factor” in predicting intention to consume milk, cheese, chocolate, and ice cream.

Using hybrid or alternative study designs, researchers have identified additional possible factors influencing purchase intentions. Bower et al measured positive associations for label information (both price- and health-related) as well as “liking” to intention to purchase fat spreads, for instance.³⁶ Meanwhile, habit appeared the greatest predictor of intention (e.g., compared to attitude) to consume olive oil or seed oils rather than butter among Italians.⁹ Supporting their babies’ health was reportedly the primary motivator for increasing DHA intake among 47 women enrolled in a Denver WIC program.⁵ In this case the women’s beliefs about DHA-infant health links, along with their attitudes about taking responsibility for such health, both likely contributed to their intentions to consume DHA. Demonstrating an opposite effect, Andrews et al found an “evaluative disclosure” (which informs consumers that a product has a per-serving nutrient (e.g., fat) level the FDA considers as “high”) to significantly *reduce* purchase intention compared to lack of a disclosure.⁴⁰

Beliefs, attitudes, habit, and intention all appear linked. This has implications for assessment of intention, which may thus involve measures of attitudes such as “liking” as well as beliefs about product nutritiousness. Recognizing the potential for habit to influence

intentions to consume certain dietary fats is also important for anyone interested in changing such intentions.

Behaviors

While likely acting along with or through other factors, knowledge (including awareness) and beliefs are among the factors researchers have associated with food-related behaviors. For example, among 2771 adult respondents in an 11-state survey, both nutrition knowledge and “appropriate” beliefs about fat and fiber were the strongest predictors of dietary practices involving them.³⁷ Specifically, those with better nutritional knowledge tended to have lower fat and higher fiber intakes, and those who believed lower fat and higher fiber would contribute to health tended to consume this way as well. ADA researchers also measured a positive correlation between n-3 consumption and awareness levels about them among adults surveyed in 2002.¹⁷ Meanwhile, respondents to the 1994-1996 DHKS who believed nutrition to be very important had a tendency to reduce overall added fats (e.g., by using low-fat dressing).²¹

Researchers have also directly correlated attitudes with behavior in multiple ways. Health or nutrition concerns reportedly motivated 74% of respondents in the 2004 United Soybean Board study to change their eating behavior during that year.¹⁸ On the other hand, Rah et al estimated that attitudes toward taste accounted for 48.6% of variability in soy consumption behavior by 204 Chicago-area women.⁸ They also concluded that such attitudes were more important behavioral influences than other TPB constructs such as subjective norms. Tuorila et al measured similarly important roles of “liking” in influencing milk ($r = 0.74$), cheese ($r = 0.70$), and ice cream ($r = 0.66$) consumption by women in California.⁴⁸ For

ice cream, concern about weight gain ($r = -0.21$) and other undesirable consequences ($r = -0.18$) worked to reduce consumption, but their independent and combined effects were less than that of “liking.”

Two additional factors that influence behavior in certain situations are self-efficacy and habit. These constructs actually fall into the categories of attitude and behavior, respectively, at least as defined herein. However, they are distinguishable from less inclusive definitions, such as that of attitude in the TPB. In the 2002 IFIC survey, researchers positively associated respondents’ self-efficacy (along with awareness) with “effort to consume more of a food component.”¹⁹ On the other hand, Saba et al concluded habit to be the best predictor of consumption of foods like meat, milk, and olive oil by Italians.⁹ For regular, repeated actions, habit may indeed play a larger role than constructs like attitude and intention in predicting behavior.⁷ Dietary habits, which commonly develop during childhood,⁴⁹ fall into this category.

As with eating behaviors, knowledge, beliefs, attitudes, and other behaviors are likely to influence use of available nutrition information. Belief in the importance of nutrition can increase reading of food labels, for instance. Such appeared to occur among DHKS respondents considering nutrition to be “very important.” These respondents read labels more frequently than others with lower regard for links between food and health.²¹

Barriers can prevent action in situations that otherwise favor behavior change (e.g., consumption of a new product). Specifically, their real or perceived presence can help explain lack of production of a given behavior by knowledge, beliefs, attitudes, intentions, or other behaviors considered to be facilitators. IFIC researchers perceived health concern relevance (i.e., consumer feelings of not being at risk) to be the biggest barrier to increased

consumption of calcium, antioxidants, and soy protein.¹⁹ Persistent unenthusiastic sensory perception of soy foods has also likely limited increases in their consumption,¹⁷ as indicated by the naming of taste as a barrier to soy consumption by 25% of IFIC survey respondents.¹⁹ Mirroring this result, 22% of ninth graders in Rhode Island reported taste as a barrier to their consuming fish.²⁰ Knowledge and food sources of soy were also reported as barriers by 17% of the IFIC survey respondents.¹⁹ For women in a Denver WIC program, apparent barriers to increased DHA consumption included cost, knowledge about preparing foods, and familiarity with foods.⁵ Meanwhile, barriers to increased purchasing of local foods reported by English focus group participants included lack of convenience in going to a farmers market rather than a supermarket, interest in supporting farmers in poor countries by buying their products, perceived lack of time to shop at farmers markets or stands, perceptions of local foods being significantly more expensive, expectations for year-round product diversity, and modern habits of shopping at supermarkets.²⁴

By using the constructs of knowledge, beliefs, attitudes, intentions, and behaviors, researchers can predict or explain a number of food-related relationships. Their application indicates great complexity in consumer thought processes and interaction with dietary fat, other nutrients, and various foods. Each factor can directly or indirectly influence the others, at times in a reinforcing or counteracting manner (see Figure 3). The results of their interaction with demographic and other variables produce the diverse set of consumer dietary behaviors apparent today. These include recent increases in n-3-containing product consumption by some through use of supplements, enriched foods, and natural sources. For food marketers, recognizing and capitalizing on apparent trends within target consumer populations likely requires well-designed research about specific consumers based on

awareness of the many mechanisms influencing thoughts and actions. Resultant marketing strategies are likely to be most effective when designed to address links between these mechanisms as well as barriers capable of disrupting their influence on actual consumption.

METHODS

Overview

This study involved several specific instruments to assess potential barriers to consumer acceptance and marketing opportunities for culinary Camelina oil by examining current levels of knowledge, beliefs, attitudes (including sensory acceptance), and behaviors. Selection of these particular factors reflected expectations of their salience in influencing dietary fat behaviors among members of the sample population (see Figure 3). Intention was not a major focus based on the novelty and lack of commercial availability of culinary Camelina oil. Meanwhile, researchers focused on marketing (e.g., strategic product placement, pricing, and promotion) as the primary potential facilitator.

Each instrument involved specific data collection methods and yielded independent results. Researchers administered a survey to a group of potential Camelina consumers in order to measure their knowledge, beliefs, attitudes, and behaviors in regard to dietary fat and n-3s. In addition, a series of sensory evaluation tests involving straight culinary Camelina oil and two simple preparations served as the primary method for sensory acceptance assessment. Six focus group discussions yielded further information about dietary fat and n-3-related knowledge levels, attitudes, beliefs, and behaviors. Finally, researchers administered a marketing-focused survey to gather feedback related to possible approaches for promoting culinary Camelina oil.

Data Collection

Sensory Evaluation

This MSU Institutional Review Board-approved portion of data collection involved assessment by participants of the sensory characteristics of culinary Camelina oil. Forty-eight people participated in high school, college, or adult groups by examining, smelling, and tasting samples. Participants were aged 14 years and older and included Bozeman area residents and cross-country skiers as well as Montana State University students and faculty. Each read and signed an informed consent form. In the case of minors, participants and a parent read and signed the active consent form. Participants were recruited using e-mail and word of mouth. Thus, researchers employed a convenience/quota sampling approach.

Test protocols were mostly consistent throughout this portion of the study. Prior to the first test, a project investigator gave instructions, including using provided water for palate cleansing purposes between tests, not interacting with other evaluators in the room, and taking as much time as necessary to make honest assessments. Evaluators assessed food samples one at a time, scoring each sample based on taste using scorecards (see Appendix E for examples) that were individually numbered according to each person. In the case of straight oils, evaluators also assessed the appearance and smell of each sample. Tests involved 9-point hedonic (a.k.a. affective) scales, for which a score of 1 corresponded to “dislike extremely,” “unacceptable,” or “extremely unpleasant” (depending on the test). Scores of 5 corresponded to “neutral,” while scores of 9 corresponded to “like extremely,” “acceptable,” or “extremely pleasant” (depending on the test). Evaluators also ranked samples from most to least preferred for each test. One difference in protocols between

groups was that college student evaluators sat at one of two large tables, in some cases facing one another, while high school and adult evaluators sat in rows all oriented in the same direction.

The first series of tests all involved straight culinary olive oil ($\frac{1}{2}$ extra virgin and $\frac{1}{2}$ pure), Canola oil, regular (as opposed to high-lignan) Spectrum flaxseed oil, and Camelina oil supplied by the Montana State University Bio-Based Institute. The Camelina oil had been pressed in a Helena, MT bottling facility with minimal refinement. Before the arrival of participants, researchers poured roughly 1 tablespoon of each oil into plastic cups (labeled with a unique random number for each oil and test) and set them in random order at each testing station. Participants began by assessing the appearance of each using a 9-point hedonic scale with a range from 1 (“unacceptable”) to 9 (“acceptable”). Participants then assessed the smell of each sample according to a 9-point scale corresponding to a range of “extremely unpleasant” to “extremely pleasant.” Next, they tasted each sample by either drinking from the cups or using a spoon and scored the sample based on a 9-point scale corresponding to a range of “dislike extremely” to “like extremely.” For the final test involving the straight oils, participants dipped pre-cut crust-less rectangular pieces of Snyder’s Whole Wheat Bread (each about 1 inch by 2 inches) into each sample and scored them as they had for the straight oil taste test.

The next test involved spreading combinations of Smart Balance® Buttery Spread and culinary oils on pieces of bread prepared in the same way as for the dip test. Researchers prepared batches of spread prior to the evaluators’ arrival by combining 4 tablespoons of spread with 2 tablespoons of each oil, whipping with a fork, spooning individual samples into plastic cups, and refrigerating the cups for 30-90 minutes. They removed samples from

refrigeration immediately prior to providing them to participants, who used plastic knives to spread each on the pieces of bread. Evaluators then consumed samples and assessed their taste using the same scale as for the straight oil taste test. One evaluator with celiac disease did not complete this test due to health concerns associated with consuming bread containing gluten, while another substituted rice flour-based bread brought from home.

The final test involved independently dipping celery and carrot sticks in researcher-prepared vinaigrettes. Batch preparation involved mixing $\frac{1}{2}$ cup white wine vinegar with $\frac{1}{2}$ cup of each oil, then adding 1 tablespoon of white sugar, $\frac{1}{2}$ teaspoon each of garlic powder and iodized salt, and 2 pinches of black pepper. Researchers then prepared individual samples by pouring roughly one tablespoon of vinaigrette into each cup, stirring just prior to doing so in order to maximize inter-sample homogeneity. These samples were left at room temperature for 30-90 minutes prior to consumption. Evaluators tasted each first by dipping celery sticks and then carrot sticks. They assessed the taste of each sample in this order in two separate portions of their score sheets. Scoring ranges were the same as for the other taste tests.

Conducting sensory evaluation tests and employing specific protocols promoted attainment of research objectives. In general, researchers expected the tests to reveal possible consumer perceptions of the acceptability of culinary Camelina oil-containing products. Using three distinct preparations involving culinary Camelina oil compared to three “competitors” facilitated assessment of possible applications for the former.

Hedonic tests were best suited to the study’s design and sample. Such tests usually involve untrained panels and provide opportunities to identify reasons for like or dislike of products.⁵⁰ Hedonic tests are also interesting for participants, which enhanced the experience

for community members involved in Montana State nutritional research for the first time. Researchers included scoring and ranking measures for each test in order to have multiple indicators of evaluators' perceptions and to reduce the number of ties. Selection of 9-point Likert scales accorded with professional opinion about their superiority compared to 5- or 7-point scales based on evaluators' tendencies to use the extremes of smaller scales.⁵⁰ Finally, by combining individual hedonic scoring and relative sample ranking, researchers had a pair of direct means for comparing product acceptability according to culinary oil type.

Test protocols were critically important to insure data integrity and avoid potential confounding factors. Using consistent amounts of ingredients, maintaining consistency in oil brands and types, consistently stirring vinaigrette batches during pouring, and providing samples at common temperatures all reduced the presence of variables that might have influenced assessments about their unique sensory characteristics.

Focus Groups

Fifty of the sensory evaluators participated in focus group discussions of 6 to 10 people each. The same facilitator led all of the discussions. Each began with an explanation of the process, including the importance of participants demonstrating mutual respect, speaking individually, and responding freely to questions asked by the facilitator. The facilitator then asked a series of questions related to participants' knowledge levels, beliefs, attitudes, and behaviors concerning dietary fat (see Appendix D). During the discussion participants received hand-outs presenting information about types of FAs (see Appendix F), PUFA metabolism (Figure 2), food FA content (see Appendix G), and food sources of n-3s (Table 1). Questions posed following review of these hand-outs assessed interest in and barriers for

consuming Camelina oil-containing and other high-n-3 foods. Researchers recorded each discussion on audio tape for later transcription.

Combined with the other methods, the focus groups provided unique insight into consumers' knowledge levels, beliefs, attitudes, and behaviors about dietary fats and n-3s. As with this project, use of focus groups in research typically accompanies additional forms of data collection.⁵¹ Product marketers regularly employ such groups to assess consumer interest in new or altered products⁵² due to participants' tendencies to feel less inhibited than when in other types of interviews. Focus groups can also generate a relatively wide range of responses and stimulate participants' memories.⁵³

As with sensory tests, use of specific protocols was critical to the collection of high quality data. The same facilitator conducted all of the groups. Each session also involved the same question order, set of hand-outs, and verbal information designed to inform participants about dietary fat-related concepts. Asking open-ended questions before providing such information facilitated assessment of pre-existing participant knowledge levels, beliefs, etc. Meanwhile, asking more directed questions about interest in specific approaches for increasing n-3 consumption following review of materials (e.g., regarding links between n6:n3 intake ratios and health) allowed researchers to test immediate effects of nutritional information on beliefs and attitudes (including interest in consuming). Use of constructs from theories such as the Health Belief Model (e.g., perceived benefits and barriers) and the Theory of Planned Behavior (e.g., attitudes) served to focus question development based on precedence for their application in understanding, predicting, or altering behaviors.

Marketing and Consumer Interest Survey

Focus group participants received (via e-mail) follow-up surveys to elicit feedback regarding a variety of Camelina marketing ideas and to gauge interest in consuming potential Camelina oil-containing products (see Appendix C). Researchers developed the first question to measure participants' interest in consuming potential Camelina oil-containing products such as mayonnaise, nut butters, spreads, dips, and salad dressings. The second included a list of food characteristics (e.g., "Montana-grown") from which respondents selected items that would likely lead them to spend more for a given food than they would for a competitor product lacking such a quality. The third item of the survey was composed of a list of possible names for culinary Camelina oil. Respondents selected those they perceived as having the most marketability (i.e., likelihood of appealing to potential Montana consumers).

The sample selection and design for the Marketing and Consumer Interest Survey was appropriate in light of research scope and budgetary limitations. Administering it to study participants who had tasted and discussed possible Camelina oil-containing products capitalized on development of personal interest and experience-based perspectives. In addition, including questions about (a) potential applications for culinary Camelina and (b) product characteristics deemed worth "spending more for" enabled researchers to partially assess Camelina marketability.

Dietary Fat Survey (Consumer Knowledge, Beliefs, Attitudes, and Behaviors)

Researchers administered an additional survey entitled "Dietary Fat Survey" to assess the dietary fat-related knowledge levels, beliefs, attitudes, and behaviors of potential Bozeman area Camelina oil-containing food consumers (see Appendix A). Respondents had

minimal exposure to project-related information prior to completing the survey. The convenience sample included 18 adult sensory evaluators (who completed the survey prior to performing sensory evaluation) as well as 45 adult attendees at a ski club pot luck in October, 2006. The survey contained four items pertaining to general dietary fat beliefs, one to dietary fat knowledge, one to attitudes related to dietary fats, and one to n-3 consumption behaviors. Additional items measured respondents' demographic characteristics, use of nutritional information sources, and general food purchasing and preparing behaviors (see Appendix A). The sensory evaluators did not complete these additional items.

The Dietary Fat Survey was a means of collecting quantitative data to develop a more complete picture of prevailing dietary fat-related levels of knowledge, beliefs, attitudes, and behaviors among potential Camelina oil-containing food consumers. Researchers developed items to specifically measure each of these potentially mediating factors of future culinary Camelina oil consumption. A more extensive survey could have included additional items to assess each factor as well as questions designed to measure self-efficacy levels or intention to consume new Camelina oil-containing products. Researchers decided to limit the survey length to two pages in order to encourage accurate completion by volunteer respondents, necessitating inclusion of a few questions deemed likely to elicit meaningful responses. Administering it specifically to adult athletes from the community promoted statistically significant results related to this potential market segment as well as identification of barriers for successful marketing efforts to members of the sample population.

Data Analysis

Sensory Tests

Sensory data analysis involved several steps. Researchers first examined the sensory evaluation scorecards (see Appendix E for examples) of each evaluator (e.g., to check for inconsistencies between relative scores and ranks) and input the data into SPSS data software spreadsheets. Using SPSS, they then calculated mean scores for each product (e.g., vinaigrette made from culinary Camelina oil) and 95% confidence intervals for each mean, both overall and according to age group. Additional statistical analysis included computing two-tailed Pearson correlations between mean scores and (separately) rankings as well as generating histograms for each score and rank distribution to assess normality.

Researchers analyzed rank data separately. Ranks were based on a scale of 1 to 4, with 1 indicating greatest preference and 4 the least. After calculating mean ranks and 95% confidence intervals for each product for each test overall and by age group, researchers calculated a rank sum difference (RSD) for each mean by measuring the difference between the sum of the ranks for each non-Camelina oil-containing sample compared to the Camelina-containing sample. Negative RSD values indicated higher (more favorable) ranking given to Camelina, while positive values indicated the opposite. Researchers then identified significant RSDs ($p \leq 0.05$) based on critical values developed by Basker.⁵⁴

Focus Groups

Researchers transcribed the taped focus group discussions into a computer Word document. Two researchers then individually examined the transcriptions and identified

comments with apparent relevance to the study purpose. This included grouping comments perceived as reflecting knowledge levels, beliefs, attitudes, or behaviors related to dietary fats.

Surveys

Analysis of the Marketing and Consumer Interest Survey simply involved summing the scores for interest in each potential Camelina oil-containing product, food characteristics selected as likely to increase consumers' willingness to pay higher prices, and possible names of culinary Camelina oil.

Researchers analyzed data from the Dietary Fat Survey in a more extensive fashion. For questions measuring food-related beliefs, they summed responses indicating agreement or disagreement and calculated percentages of the total that those in agreement or disagreement represented. For each item designed to test dietary fat knowledge, researchers computed frequencies (expressed as percentages) by summing correct responses and comparing them to the number of total responses. In addition, they calculated net knowledge scores for each respondent as the number of correctly identified fats minus the number of nutrients incorrectly perceived as fats. For the questions about (a) motivations for making specific food purchases and (b) actual high-n-3 product purchasing behaviors, researchers again computed frequencies by summing the number of each of the responses (including write-ins) and comparing them to the number of respondents. Background question analysis involved calculating means (e.g., for age), summing numbers of group representatives (e.g., for sex), and computing frequencies (again expressed as percentages).

Researchers next examined the apparent relationships between different variables measured on the survey and several other combinations created afterwards. First, they

checked for correlations between variables such as age, sex, knowledge score, ability to identify ALA as a fat, self-reported n-3 intake, and n-3 intake frequency (see Table 5). Then they conducted multiple regressions to assess the relative contributions of age, sex, education level, ALA recognition, and fat knowledge score on n-3 intake and n-3 intake frequency. Finally, they computed means and 95% confidence intervals for a number of items, such as knowledge scores by age group and n-3 intake (yes/no) by sex.

RESULTS

Sensory Evaluation

The results of the sensory evaluation tests were decidedly mixed and tended to depend on the sample composition, oil types, and participant age group. Including all participants, the overall assessments of culinary Camelina oil according to a series of 9-point Likert scales were fairly neutral. A few specifically favored it, while others found its appearance, odor, or taste to be unacceptable. Mean overall and by-age-group scores are presented in Table 2, while ranking results appear in Table 3. In addition, Figure 4 illustrates overall score results for each test. In short, the results for Camelina-containing samples were the following:

- There were no significant differences between assessments of oil appearance, and evaluation of Camelina oil sample appearance indicated acceptability, particularly among adults.
- Evaluation of the odor of straight Camelina oil samples indicated unacceptability relative to a neutral score (of 5.0) as well as compared to the other oils, although not significantly among adults.
- Evaluation of the flavor of straight Camelina oil samples consumed with and without bread indicated unacceptability relative to a neutral score as well as compared to the other oils (just compared to olive oil in the straight flavor test), although not significantly among adults.
- Evaluation of the taste of samples of Camelina oil combined with a buttery spread indicated unacceptability relative to a neutral score as well as compared to the other oils.

- Evaluation of the taste of a Camelina oil-based vinaigrette indicated acceptability relative to a neutral score, especially among adults.

Appearance assessments varied widely, reflecting lack of a shared perception for what a culinary oil should look like (see Table 2 and Figure 4). The net score for Camelina on a scale of “unacceptable” to “acceptable” was 5.7 ± 0.6 , indicating a slight overall tendency toward acceptability. Olive oil received an overall score of 6.8, indicating the most acceptance. The adult participants tended to score Camelina more favorably than did their younger counterparts, giving it a mean score of 7.0 ± 0.9 . Meanwhile, there were no significant differences between the overall rankings of Camelina oil sample appearance compared to the others (see Table 3).

Both Camelina and flaxseed oil were a relatively deep yellow, which for some was off-putting. These participants commented that these products looked “like pee” or were “unsettling,” “greasy and kind of gross,” or simply “too yellow.” On the other hand, a few participants either preferred the appearance of the darker yellow oils to the relatively clear Canola and slightly greenish olive or else showed no preferences for different appearances.

The evaluators’ overall perception of Camelina’s odor was negative, reflected by a sub-neutral score of 4.4 ± 0.6 on a scale of “extremely unpleasant” to “extremely pleasant” and overall rank of 3.2 ± 0.3 . Many wrote comments about the pungent nature of the Camelina samples in relation to the others. Characterizations of this odor included “a lot like plants and dirt,” “earthy,” “foul,” “like grass or hay,” “strange,” “herb-like,” “slightly molded,” and “a little musty.”

Table 2. Sensory Evaluation Mean 9-point Likert Scale Scores and 95% Confidence Intervals for Like and Dislike by Sample, Group, and Test.

	Oil	High School	College	Adult	Overall
Str. Appear.	Camelina	5.4 ± 1.0	4.6 ± 1.3	<u>7.0</u> ± 0.9	<u>5.7</u> ± 0.6
	Canola	5.9 ± 1.2	5.2 ± 1.3	5.8 ± 1.3	5.7 ± 0.7
	Flaxseed	5.2 ± 0.9	4.7 ± 1.0	7.0 ± 0.9	5.7 ± 0.6
	Olive	6.7 ± 1.0	6.3 ± 1.1	7.3 ± 0.7	6.8 ± 0.5
Str. Odor	Camelina	4.3 ± 1.0	3.3 ± 0.8	5.5 ± 1.1	4.4 ± 0.6
	Canola	5.9 ± 0.7	5.3* ± 0.6	5.2 ± 0.4	5.5* ± 0.3
	Flaxseed	6.3* ± 0.7	5.4* ± 0.5	5.7 ± 0.7	5.8* ± 0.4
	Olive	6.3* ± 1.0	5.3* ± 0.5	6.4 ± 1.1	6.0* ± 0.5
Str. Flavor	Camelina	4.4 ± 1.2	3.6 ± 0.9	5.1 ± 1.1	4.4 ± 0.6
	Canola	5.0 ± 0.9	5.3 ± 0.9	5.3 ± 0.6	5.2 ± 0.4
	Flaxseed	5.6 ± 0.9	5.2 ± 1.0	5.1 ± 0.9	5.3 ± 0.5
	Olive	5.3 ± 1.4	5.5* ± 0.9	6.1 ± 1.2	5.6* ± 0.6
Bread Dip	Camelina	4.0 ± 1.1	4.1 ± 1.3	4.7 ± 1.0	4.3 ± 0.6
	Canola	6.1* ± 0.6	5.7 ± 0.7	5.5 ± 0.4	5.7* ± 0.3
	Flaxseed	6.2* ± 1.1	5.4 ± 1.1	5.8 ± 0.8	5.8* ± 0.5
	Olive	5.1 ± 1.3	6.1 ± 1.0	5.5 ± 1.3	5.6* ± 0.7
Bread Spread	Camelina	3.9 ± 1.3	4.1 ± 1.5	4.4 ± 0.9	4.2 ± 0.5
	Canola	7.5* ± 0.7	5.5 ± 1.1	7.1* ± 0.8	6.7* ± 0.5
	Flaxseed	6.6* ± 0.8	6.3 ± 0.8	6.1 ± 0.8	6.3* ± 0.4
	Olive	5.8 ± 1.1	6.3 ± 1.0	5.8 ± 1.2	6.0* ± 0.6
Celery Dip	Camelina	5.4 ± 1.0	4.9 ± 1.2	<u>6.2</u> ± 0.6	<u>5.5</u> ± 0.5
	Canola	5.8 ± 0.9	6.5 ± 1.0	5.6 ± 1.1	5.9 ± 0.6
	Flaxseed	6.1 ± 0.7	5.8 ± 1.0	6.5 ± 0.8	6.2 ± 0.5
	Olive	5.9 ± 1.5	6.3 ± 0.8	5.2 ± 1.3	5.8 ± 0.7
Carrot Dip	Camelina	5.7 ± 1.0	4.5 ± 1.3	<u>6.5</u> ± 0.8	<u>5.6</u> ± 0.6
	Canola	5.3 ± 1.2	6.1 ± 1.0	6.1 ± 0.8	5.8 ± 0.5
	Flaxseed	6.5 ± 0.9	5.7 ± 0.9	5.9 ± 0.9	6.0 ± 0.5
	Olive	4.7 ± 1.4	6.3 ± 0.9	5.7 ± 1.3	5.5 ± 0.7

1 = dislike extremely, 5 = neutral, and 9 = like extremely. Asterisks indicate significantly higher assessment of a competitor compared to Camelina. Bold black figures are significantly ($p < 0.05$) less than 5, indicating dislike. Bold underlined figures are significantly greater than 5, indicating like. Italicized figures indicate significant differences between age groups.

Table 3. Sensory Evaluation Mean Ranks and Rank Sum Differences.

	Oil	H. School		College		Adult		Overall	
Str. Appear.	Olive	1.9 ± 0.6	10.5	1.9 ± 0.5	14.0	2.2 ± 0.5	1.5	2.0 ± 0.3	26.0
	Camelina	2.6 ± 0.6	-	2.8 ± 0.7	-	2.3 ± 0.5	-	2.5 ± 0.3	-
	Flaxseed	2.9 ± 0.4	-5.0	2.7 ± 0.5	2.0	2.3 ± 0.5	-1.0	2.6 ± 0.3	-4.0
	Canola	2.6 ± 0.7	0.5	2.6 ± 0.6	4.0	3.3 ± 0.6	-18.5	2.8 ± 0.4	-14.0
Str. Odor	Olive	2.3 ± 0.6	18.0	2.0 ± 0.5	24.0*	2.2 ± 0.7	5.5	2.2 ± 0.3	47.5*
	Flaxseed	2.2 ± 0.3	20.0*	2.2 ± 0.6	21.0*	2.6 ± 0.5	-1.5	2.3 ± 0.3	39.5*
	Canola	2.1 ± 0.6	22.0*	2.2 ± 0.5	21.0*	2.8 ± 0.5	-5.0	2.4 ± 0.3	38.0*
	Camelina	3.4 ± 0.6	-	3.6 ± 0.5	-	2.5 ± 0.6	-	3.2 ± 0.3	-
Str. Flavor	Olive	2.6 ± 0.7	7.0	2.0 ± 0.5	22.0*	2.0 ± 0.6	12.5	2.2 ± 0.3	41.5*
	Flaxseed	2.0 ± 0.5	17.5	2.1 ± 0.6	21.5*	2.8 ± 0.5	-1.0	2.3 ± 0.3	38.0*
	Canola	2.3 ± 0.6	11.5	2.5 ± 0.6	14.5	2.6 ± 0.5	2.5	2.5 ± 0.3	28.5
	Camelina	3.1 ± 0.6	-	3.4 ± 0.5	-	2.7 ± 0.6	-	3.0 ± 0.3	-
Bread Dip	Flaxseed	2.0 ± 0.7	17.0	2.1 ± 0.6	18.5	2.3 ± 0.5	15.5	2.1 ± 0.3	51.0*
	Olive	2.8 ± 2.2	5.0	1.9 ± 0.5	21.0*	2.2 ± 0.6	17.5	2.3 ± 0.3	43.5*
	Canola	2.1 ± 0.4	16.0	2.7 ± 0.5	8.5	2.3 ± 0.4	15.0	2.4 ± 0.3	39.5*
	Camelina	3.1 ± 0.6	-	3.3 ± 0.5	-	3.3 ± 0.5	-	3.2 ± 0.3	-
Bread Spread	Canola	1.7 ± 0.5	25.5*	2.7 ± 0.6	8.0	1.7 ± 0.5	31.0*	2.0 ± 0.3	64.5*
	Olive	2.6 ± 0.6	11.5	1.9 ± 0.5	20.0*	2.3 ± 0.5	19.5	2.3 ± 0.3	51.0*
	Flaxseed	2.2 ± 0.5	18.0	2.2 ± 0.4	16.0	2.6 ± 0.4	15.5	2.3 ± 0.2	49.5*
	Camelina	3.4 ± 0.6	-	3.2 ± 0.6	-	3.5 ± 0.5	-	3.4 ± 0.3	-
Celery Dip	Flaxseed	2.3 ± 0.7	9.0	2.3 ± 0.6	7.0	2.7 ± 0.7	5.5	2.3 ± 0.3	21.5
	Olive	2.3 ± 0.7	10.0	2.3 ± 0.6	9.0	2.7 ± 0.7	-3.0	2.4 ± 0.4	16.0
	Canola	2.5 ± 0.7	7.0	2.3 ± 0.7	10.0	2.7 ± 0.4	-4.5	2.5 ± 0.3	12.5
	Camelina	2.9 ± 0.6	-	2.9 ± 0.6	-	2.5 ± 0.7	-	2.8 ± 0.3	-
Carrot Dip	Flaxseed	2.1 ± 0.5	1.0	2.5 ± 0.6	9.0	2.6 ± 0.5	-3.0	2.4 ± 0.3	7.0
	Camelina	2.1 ± 0.6	-	3.1 ± 0.6	-	2.4 ± 0.6	-	2.5 ± 0.4	-
	Olive	3.0 ± 0.6	-14.0	2.1 ± 0.5	14.0	2.5 ± 0.8	-2.5	2.6 ± 0.4	-2.5
	Canola	2.8 ± 0.6	-11.0	2.3 ± 0.7	11.0	2.5 ± 0.7	-2.5	2.6 ± 0.3	-2.5

Ranks are based on a scale of 1 to 4 (1 = most preferred and 4 = least preferred). Each RSD number is the difference between the sum of the ranks for Camelina compared to a competitor oil for a given test. Negative numbers indicate more favorable ranking given to Camelina and positive numbers the opposite. Asterisks indicate significant differences ($p \leq 0.05$) based on critical values from Basker.⁵⁴

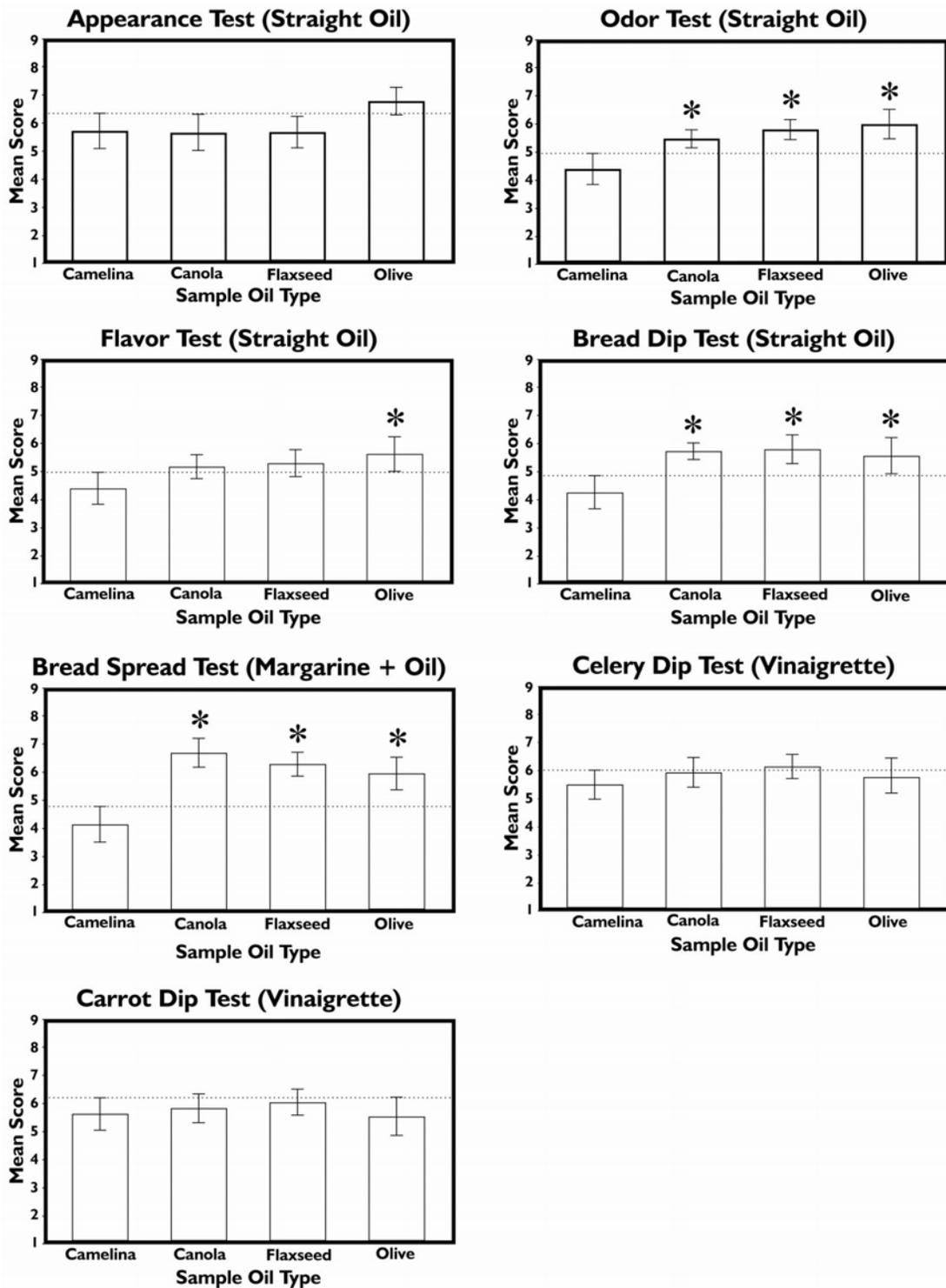


Figure 4. Sensory Evaluation Test Mean Scores. Bars represent 95% confidence intervals for each mean score. The dotted line extends the upper bound for the Camelina score. Asterisks indicate significantly lower evaluation of Camelina compared to other oils.

The other samples all received scores that were significantly higher than both Camelina's and the neutral score of 5.0, indicating their relative acceptability. The rank sum difference (RSD) values of the other samples were also all statistically significant and positive compared to Camelina's (see Table 3). Descriptions of these samples included that they were "really pleasant" (olive) or that they had "no smell" (Canola and flaxseed). Differences in assessments were greatest among the college-aged participants, who gave Camelina a significantly sub-neutral mean score of 3.3 ± 0.8 . In contrast, adult participants' scores did not differ significantly between the different samples, and all were greater than 5.0 (although not statistically significantly so).

Results of the straight sample flavor test mirrored those of the odor test. This and subsequent tests all involved 9-point scales for flavor assessment from "dislike extremely" to "like extremely." Camelina again received a net score of 4.4 ± 0.6 , indicating general perceptions of unacceptability. None of the other oils' mean scores were under 5.0, but only that of olive oil (5.6 ± 0.6) was significantly higher than the Camelina score. Meanwhile, the overall 3.0 ± 0.3 ranking of Camelina samples was significantly worse than those given to samples containing olive or flaxseed oil.

Comments about the Camelina samples ranged from them having little taste to being "bitter," "woody," "grassy," or "aromatic." While evaluators generally found Canola to be tasteless, comments about olive oil included "toxic" and "gross," while for flaxseed "like flour," "a little grassy," and "pleasant." As in the odor test, the responses of the college-aged participants were the most negative, reflected by various comments as well as the group mean score of 3.6 ± 0.9 . Meanwhile, adults again scored and ranked all the samples similarly and tended to find all of them at least somewhat acceptable.

In the test involving dipping wheat bread in straight oil samples, overall Camelina scores again were lower than the others. Canola and flaxseed scores improved significantly compared to the straight flavor test but did not differ from olive. All three were significantly positive and greater than the sub-neutral score of 4.3 ± 0.6 for Camelina. Not surprisingly, Camelina received the poorest rankings, and the overall mean of 3.2 ± 0.3 was significantly behind each of the other samples. While rank sum differences were not statistically significant within the adult group, there was a strong trend toward ranking the other three samples ahead of Camelina.

A few participants had negative comments for olive oil (e.g., “too oily”), but many more commented on Camelina. For some the bread made it “more tolerable” or lent it “a pretty good taste,” while others suggested that it tasted “fishy,” “nutty,” “carrot-like,” “weird and strong,” or “like broccoli.”

Camelina fared most poorly on the bread spread test (see Table 2), for which researchers combined oils with Smart Balance® Buttery Spread in a 1:2 ratio and spread the mixture on whole wheat bread. The net score of 4.2 ± 0.7 for Camelina was significantly lower than those for the other three oils. Likewise, its overall ranking of 3.4 ± 0.3 was significantly worse than the others. Each age group similarly scored and ranked Camelina lowest. For instance, the adult group mean score was 4.4 ± 0.9 , and the mean rank was 3.5 ± 0.3 .

While some participants detected no taste differences, others commented that the part-Canola sample tasted “just like butter,” or that the part-olive sample was a bit weird in color and taste. Meanwhile, participants described the part-Camelina sample as “just too strong,”

“unpleasant,” “not completely unpleasant,” “good with a crazy taste,” “stranger” and “heavier than the others,” or in one case, “horrible.”

Assessments of Camelina as part of a simple vinaigrette were significantly better. In separate tests, evaluators deemed it acceptable both for dipping celery (5.5 ± 0.5) and carrots (5.6 ± 0.6). There were no significant differences in any of the rankings, although Camelina-containing vinaigrette samples tended to fair better on the carrot dip test compared to the celery dip test. As with several of the previous tests, adults scored Camelina-containing samples higher than their younger counterparts. In fact, adults ranked Camelina first (although not significantly ahead) among all the samples on the carrot dip test and second on the celery dip test (see Table 3). The mean adult scores were 6.2 ± 0.6 on the celery dip test and 6.5 ± 0.8 on carrot dip test, both of which were significantly greater than a neutral acceptability score of 5.0.

Unlike in the previous tests, only a few evaluators commented about the samples containing Camelina. High school and college students tended to be less enthusiastic than their older counterparts. Comments about samples containing Camelina included that they tasted “awful, almost like feet” or had a “nasty hay-like aftertaste.”

Focus Groups

The results of the focus groups indicated large variation in dietary fat knowledge, beliefs, attitudes, and behaviors within the sample of Bozeman-area athletes. Some were engaged in multiple strategies for achieving significant intakes of n-3s, while others exhibited only vague awareness of their existence or possible roles in influencing health.

Question 1

The first question posed was “have you read or heard anything in the last year about recommended intakes of dietary fat?” Researchers included it to gauge general awareness of recent health messages related to dietary fat intake. Responses and resulting discussions tended to fall into one of several categories, including the idea that some fats or oils promote health more than others. Typifying this perception were comments like “there’s a good kind of fat that you need in your diet, and then there’s like the bad kind of fat that you’re supposed to have not very often.”

Participants mentioned fats deemed good or bad either by naming a type such as “omega” or “unsaturated” or by referring to a food source considered to be a major source. Foods regularly associated with “good fats” included fish in general and salmon specifically, as well as avocados. Meanwhile, fats described as being “bad” (most commonly) or “deleterious” included saturated fat, *trans*-fat, and hydrogenated oils, along with “hydrogenated stuff.”

Other responses related to macronutrient intake recommendations, either generally or in terms of specific percentages or absolute amounts. One participant offered “I think another recommendation... is to not take too much [fat] at a time because your body can only process so much.” Another responded “I’ve also heard that it’s important to have fat, and that our emphasis on no fat is not a good way to go.” Echoing this sentiment were comments such as “low-fat diets are dead” and “the low-fat craze is not what you want to do, and you need to get those kinds of oils.” Only in one group did the discussion involve recommended proportions of total dietary energy from fat, with participants mentioning 25%, 30%, and 35% as possibilities.

The majority seemed to recall some sort of recommendation related to a food or fat category, although few cited specific information sources. One college student reported hearing but only vaguely recalling recommendations from a sports nutrition course. More commonly cited sources included “no trans-fat” labels on packaged foods, “MSN or the internet,” and conversations with other people. Several participants seemed confused about what they perceived as a large variety of messages seemingly subject to change.

Representatively, one commented:

We’re like kind of on the cusp of understanding so much about nutrition and we hear so much that, and one thing one day and one thing another day, and so there’s kind of a confusion. I think I know something about that but I’m not sure, and I need to go back and look. It’s confusing.

Question 2

The second question posed was “have you read or heard anything in the last year about recommended intakes of n-3s?” A few participants reported having read or heard nothing at all, while some others recalled only general recommendations such as “just to increase.” Reported recommendations involving oil included “a tablespoon, kind of daily,” “a thousand milligrams, 2000, 3000,” and a “couple of tablespoons a day of... flaxseed oil or fish oil.” Likewise, reported recommendations for fish included “a couple times a week.” One participant reported a recommendation for daily intake of “several servings of omega-3s, either from eggs or fish or a[n] oil source.” “The eggs” came up in another group’s discussion as well. Meanwhile, no participants mentioned a specific information source except for one who stated “my Mom told me.”

Question 3

The next question was “what is the relationship between consuming certain types of fat and health?” A comment made prior to this question was that n-3s were apparently “good for you [and useful for] just keeping up, pretty much the entire body running smoothly.” After the question’s provision, several participants made additional comments related to either positive or negative health outcomes associated with fat intake in general. Positive outcomes included “normal body function,” “skin health,” obtaining the “vitamins which are dissolvable only in oil,” helping “build... fat around your brain,” and making “your nails stronger... or your hair grow faster.” One participant stated that “you need it for survival.” Comments about negative associations with excessive fat consumption centered mainly on obesity, and included “you get fat kids.” One participant also mentioned early menarche in girls as possibly related to dietary fat intake.

The majority of comments involved associations between specific types of fats and health. While one participant remarked that n-3s were “good for your heart,” much more prominent were negative associations with saturated or *trans*-fats. For saturated fat, the concept of “clogged arteries” arose on multiple occasions, although one participant specifically linked them to “animal fats.” Other outcomes linked to saturated fats included “heart problems,” “strokes,” and increased “blood pressure and cholesterol.” One participant focused on high saturated fat intakes by many Americans, stating “they don’t need as much as they’re eating.” The comments about outcomes of *trans*-fat consumption were nearly identical to those for saturated fat, with “clogged arteries” again arising several times. Others included “heart problems,” “heart attack,” “obesity,” “cholesterol,” and

“diabetes.” One participant remarked “*trans*-fats are totally foreign to the body, so the body doesn’t know what to do with it, but I don’t remember what.”

Question 4

The fourth question was “do you know anything about characteristics of omega-3s and other types of fats?” Several participants had some specific knowledge about differences between n-3s and n-6s, such as in terms of “where their double bonds are.” The high school students generally did not, although one explained “it’s the unsaturated ones that are better I think, because...they don’t have a hydrogen attached to every available place.” Comments that “they’re fluid at room temperature” as well as “unsaturated” related to physical properties. Several participants remarked about the tendency for n-3-containing oils to “oxidize,” “change their form more readily,” “go rancid,” become damaged by “sunlight or high heat,” or “change and get bitter.” Other comments centered on perceived positive health effects. “Don’t they catch free radicals?” asked one participant. “They’re supposed to help,” “they’re essential fats,” and “they’re sort of better, and so they go through your system better than saturated ones or something,” remarked others. Another participant asked “isn’t the belief that they pull out surplus LDL cholesterol?” Others commented about n-3s’ role in adding flavor and their being “naturally occurring.”

Several participants made comments about saturated and *trans*-fat characteristics. Those about saturated fats included that “they’re completely saturated hydrocarbons,” that they “have more hydrogen,” and that “there’s a saturation. It’s a saturated bond means there’s a double bond and unsaturated is like a single bond or something with saturated.” *Trans*-fat-related comments, meanwhile, focused on synthesis, chemical structure, or physical

properties. One participant stated “*trans*-fats, they’re all fake. They’re man-made because we added hydrogens to those fat molecules, to close out all the open bonds.” Others mentioned *trans*-fats’ linearity, stability, ability “to solidify things” like margarine, and benefit to “the food industry so they can transport foods better [and have them] last longer.”

Question 5

The fifth question (actually two) was “what do you know about foods that contain omega-3 fatty acids? Do you know any?” Several participants were aware of flaxseed oil’s significant n-3 content. Other perceived sources mentioned were fish, fish oil, cod liver oil, salmon, eggs from chickens fed “special food,” grass-fed chickens (vs. “traditional boxed chickens”), wheat germ, walnuts, and a transgenic pig. Two comments alluded to the need “to eat healthy to get your omega-3s” and the absence of these fats in “foods that someone with a poor diet would really eat a lot of.” One participant distinguished between plant and marine sources of n-3s:

I’d actually thought that flaxseed oil had kind of some similar fats, same kind of fat quality as some of the fish oil that everyone’s psyched about except that it tastes like fish... But I just heard and I don’t know if this is true, that it’s actually, most humans lack the necessary enzymes to really fully dissolve or... take advantage of the flaxseed oil.

Question 6

To uncover possible barriers to n-3 intake, the next question posed was “what do you think currently prevents you from including any or more high-n-3 products in your diet?” Although several came up repeatedly, responses varied widely between participants. Some were concerned about storage challenges, stating that “flaxseeds are hard to keep,” that “it seems you have to eat it and then throw it away,” and that “rancidity with oils is of concern.

How long is the shelf life? How long it keeps and how it converts if it's been there too long." Geography factored into several participants' perceived difficulty obtaining n-3s, as did availability in general. One stated "we live in Montana, and it's hard to get good fish." Several mentioned high prices of fish, flaxseed, walnuts, and salmon as being a barrier, with one adding "especially being a student." Others referred to taste perceptions. "If it has really strong flavor, you don't want that in your cooking" remarked one participant. "Flaxseed oil isn't something that you're gonna wanna put on your salad in general, or, if you're used to it, yes, but getting the kids to eat it is a little tough," offered another.

Other comments about challenges with integrating n-3s may have alluded to sensory or chemical characteristics. "They're hard... if you don't know how to, like, cook with them" remarked one participant, while another suggested that oil marketers develop a cookbook or provide "recipe suggestions that are easy." Related comments included "you can't like just grab... salmon out of the fridge," "it's not convenient," "it's not like you'd grab... crackers or something," "you don't... drink flaxseed oil," and "you have to grind [flaxseeds]."

Several participants' comments alluded to psychological barriers to increased fat consumption of any kind by American consumers. These included lingering perceptions that "fats are bad," possibly originating from previous recommendations to keep fat "limited or low." Several participants mentioned lack of awareness or consistent education (e.g., "no one knows that they're supposed to have omega-3s"). One stated "I have to have stuff hammered into my head a lot so it stays there." Others mentioned safety or ethical concerns including "over-harvesting and lead," mercury, and pesticides used in conventional high-n-3 plant agriculture. Organic production methods were a priority for several participants, one of whom explained:

You're talking to, yeah, an exercise crowd, people that are maybe fairly educated about the health of certain things, and why would you even cross over to something that might have pesticides in it, when you've got flax oil that you can buy organically? You'd have to *love* Camelina and disregard any, you know, any negative stuff on pesticides, which really is the bottom line for me.

Another group of comments related to habitual and societal influences on dietary behaviors. One participant remarked "part of it's... the diet you had growing up. We never, I never ate a lot of... fish." Another added "we ate some fish but none of the vegetable [sources]... so now I never eat them." Other comments included that regular n-3 intake is not part of "an American... diet," and that "Americans eat out a tremendous amount" and don't typically know what "we're eating when we eat out."

Question 7

To help identify potential Camelina marketing approaches, the next question was "what might prompt you to eat more high-n-3 products?" Most of the participants answered in specific reference to Camelina oil. Several mentioned availability and cost as big factors, with one stating "if you can lower the cost of... Camelina oil (presumably below that of other sources of n-3s), you can get a market." Others suggested specific foods that might be attractive if made with Camelina, including chocolate chip cookies, fish crackers, or vinaigrettes, and one participant recommended incorporation into school meals. "Marketing's huge," commented another, in reference to nutritional information on packaging as well as "Made in Montana" labeling. Many others shared opinions about the potential value of providing information about health effects. One participant felt that the most effective information would provide "proof" of positive health effects, adding "I... believe you, but... more people would go along with it if they had... an example or what

have you.” Perception of health benefits might influence people to “eat something that maybe they don’t like the taste of as much,” remarked another.

Question 8

To further explore potential marketing angles, the final question posed was “if you either wanted to start eating n-3s or else wanted to eat more of them, how would you go about it?” A number of participants favored using salad dressing, either by making it at home or by buying a pre-made product such as Annie’s or Drew’s. Other responses included “walnuts, I guess I could eat more walnuts,” “mix oil in smoothies,” “the spreads or the dipping the bread,” and “chocolate chip cookies with walnuts in them.” One participant mentioned possibly sprinkling high-n-3 oil on pasta in place of olive oil, while another cited grinding flaxseeds and adding them to muffin recipes.

Marketing and Consumer Interest Survey

Of the 18 adults who participated in the sensory evaluation portion of the study, 12 (67%) responded to the e-mailed Consumer Interest Survey. Potential high-n-3 products generating the most interest were nut butters (67% of respondents), hummus (58%), clear salad dressing (50%), and baked goods (50%). For a complete list of results, see Appendix C.

Among food characteristics considered most likely to motivate respondents to spend more for a given product compared to another without that characteristic, 92% selected “organic” as well as “produced with less stress on the environment.” Other popular choices were “grown in Montana” (83%) and “high in omega-3 fats” (75%). Interestingly,

“processed in Montana” (50%) was less popular. One respondent also wrote in “sold at a place like the Co-Op or other locally owned store.”

For names of culinary Camelina oil considered to be most marketable, 75% of respondents selected “Montalina,” while “Neurolina” and “Kalyalina” each garnered votes from 33%. One respondent also commented “Kalyalina, Montalina, and Camontina are okay. THE OTHERS PLEASE NO.”

Dietary Fat Survey

A total of 63 Bozeman area adults associated with the local Bridger Ski Foundation Nordic Club completed the survey (see Appendices A and B), 38 of whom supplied demographic data. Respondents’ ages ranged from 22 to 67 years, and the mean was 46.5 years. There were 20 male and 18 female respondents, and 53% had at least some post-baccalaureate college experience. Of the rest, 32.5% were college graduates and 13% had some college experience. Just 3% had no college experience.

Nearly all (98%) of the respondents selected “disagree” or “strongly disagree” in response to the statement, “all fats in foods have basically the same effects on health.” On the other hand, nearly all (94%) selected “agree” or “strongly agree” in response to the statement “some types of fats are healthier to eat than others.” The next item produced less of a clear consensus, with 87% disagreeing or disagreeing strongly with the statement “most nutrition experts believe fat has no beneficial health effects.” Finally, 95% either agreed or strongly agreed with the statement “eating sufficient amounts of certain fats is important for good health.” See Appendix B for complete results.

The next survey item involved selection of nutrients perceived to be types of fats (see Table 4). The greatest percentage of correct answers was for “saturated,” which 97% of respondents selected. Other percentages, in descending order of correct selection, were 95% for “polyunsaturated,” 91% for both “*trans*-” and “monounsaturated,” 78% for “omega-3s,” 62% for “omega-6s,” 24% for “alpha-linolenic,” 16% for “EFAs” (essential fatty acids), and 6% for both “EPA” and “DHA.” While 14% incorrectly selected “vitamin E,” nearly half (46%) selected “cholesterol.” No respondents selected “zinc,” “fiber,” “ascorbic acid,” “protein,” or “sodium,” while one selected “carbohydrate.”

Table 4. Rates of Successful Identification of Dietary Fats and Non-Fats

Nutrient Name	Fat	Percentage Correct
Saturated	Yes	96.8%
Polyunsaturated	Yes	95.2%
Monounsaturated	Yes	90.5%
<i>Trans</i> -	Yes	90.5%
Omega-3s	Yes	77.8%
Omega-6s	Yes	61.9%
Alpha-linolenic	Yes	23.8%
EFAs	Yes	15.0%
EPA	Yes	6.3%
DHA	Yes	6.3%
Fiber, zinc, ascorbic acid, protein, sodium	No	100%
Carbohydrate	No	98.4%
Vitamin E	No	85.7%

The next item was a question about reasons for buying or eating certain foods. Nearly all the respondents (94%) selected “they keep me healthy” as a reason, followed by “they taste good” (89%), “I can afford them” (65%), and “they are quick and convenient” (43%). “Write-in” reasons (3%) included food color and support of endurance racing performance.

Next was a question about frequency of n-3 consumption. In order of increasing frequency, 10% of respondents selected “less than once per week,” 30% selected “1-5 times per week,” 25% selected “daily,” and 3% selected “more than once per day.” The largest group of respondents, 33%, selected “I don’t know.”

Respondents were apparently confused by questions about weekly home meals prepared and weekly commercially prepared foods purchased. Many of the answers indicated such confusion by not accounting for a significant number of meals (data not shown), necessitating exclusion of the results of these two measures.

Another item about weekly shopping behaviors was the question “on average how many times do you shop for food to bring home each week?” In order of frequency, 10% selected “none,” 20% selected “0-1,” 33% selected “2,” 18% selected “3,” and 20% selected “more than 3.”

The last two items permitted multiple answers and concerned sources of current and desired nutritional information. The first question was “where do you currently obtain nutritional information?” In order of frequency, 50% of respondents selected “friends,” 28% selected “traditional health practitioner,” 23% selected “alternative health practitioner,” 20% selected “parents,” 20% selected “internet,” 18% selected “television,” and 10% selected “school.” In addition, 28% wrote in “magazines.” Less common write-in information sources included labels, books, professional journals, a spouse, the newspaper, and health

stores. Meanwhile, in response to the question about places respondents wanted “to find more nutritional information,” 30% selected “school” and 30% “internet.” Other common responses were “traditional health practitioner” (28%) and “television” (25%).

Researchers developed several categorical variables to assist in data analysis. These included “knowledge score/KnowScore,” which was the percentage of correct identification of 17 listed items as either a fat or not a fat. Based on confusion about respondent reasoning, researchers excluded cholesterol from consideration in this score. Other categorical variables were “age decade/AgeDcd” (20s, 30s, 40s, 50s, and 60s), “age groups/AgeGrp” (20s-30s, 40s, and 50s-60s), “education level/Ed” (non-college graduate, college graduate, and post-graduate experience), “n-3 YN intake” (for which “I don’t know” answers were excluded), n-3 YNM (for which “I don’t know” answers were considered “no”), “n-3 frequency/n3Freq” (ranked with “<once/wk” = 0, “1-5 times/wk” = 1, “daily” = 2, “>once/d” = 3, and “I don’t know” excluded), and n-3 frequency 2/n3Freq2” (“daily” and “>once/d” = 1 and all other answers = 0).

A handful of Pearson correlations between the various initial and categorical variables were statistically significant ($P < 0.05$) or close to being so (see Table 5). ALA recognition was positively correlated with knowledge score ($R = 0.466$, $p = 0.002$). Negatively correlated with n-3 intake (n3YNM) were education level ($R = -0.320$, $p = 0.044$) and male sex ($R = -0.382$, $p = 0.018$). In addition, negatively correlated with n3YN were age ($R = -0.337$, $p = 0.092$) and age group ($R = -0.330$, $p = 0.099$).

The linear regression results (not shown) yielded a lone significant effect, that of age on n-3 intake (“n3YN”), for which researches counted “I don’t know” answers as equivalent to none ($\beta = -0.444$, $p = 0.07$). Otherwise, none of the original or categorical variables had a

significant effect on dependent variables (e.g., knowledge score, n-3 intake, or n-3 intake frequency).

Table 5: Correlations Between Variables Assessed on the Dietary Fat Survey

		ALA Recog- nition	Know- ledge Score	Sex (Male)	Age	Educa- tion Level	n3YN	n3YNM	n3Freq
Know- ledge Score	Pearson Corr.	0.466							
	Sig. (2-tailed)	0.002							
	N	40							
Sex (Male)	Pearson Corr.	0.043	-0.24						
	Sig. (2-tailed)	0.798	0.146						
	N	38	38						
Age	Pearson Corr.	0.129	-0.244	0.096					
	Sig. (2-tailed)	0.44	0.139	0.566					
	N	38	38	38					
Educa- tion Level	Pearson Corr.	0.124	-0.233	0.082	0.136				
	Sig. (2-tailed)	0.447	0.147	0.624	0.416				
	N	40	40	38	38				
n3YN	Pearson Corr.	0.147	0.183	-0.282	-0.337	-0.035			
	Sig. (2-tailed)	0.463	0.36	0.163	0.092	0.862			
	N	27	27	26	26	27			
n3YNM	Pearson Corr.	-0.136	0.21	-0.382	-0.142	-0.32			
	Sig. (2-tailed)	0.401	0.192	0.018	0.396	0.044			
	N	40	40	38	38	40			
n3Freq	Pearson Corr.	0.192	0.027	-0.264	-0.108	0.109			
	Sig. (2-tailed)	0.337	0.892	0.193	0.599	0.588			
	N	27	27	26	26	27			
Age Decade	Pearson Corr.	0.159	-0.184	0.039	0.963	0.201	-0.293	-0.13	-0.109
	Sig. (2-tailed)	0.341	0.268	0.818	0	0.226	0.147	0.437	0.595
	N	38	38	38	38	38	26	38	26
Age Group	Pearson Corr.	0.082	-0.16	0.06	0.873	0.231	-0.33	-0.177	-0.128
	Sig. (2-tailed)	0.626	0.338	0.722	0	0.163	0.099	0.287	0.532
	N	38	38	38	38	38	26	38	26

Noteworthy tendencies and significant correlations are indicated by bold significance values. Correlations between Age Decade and Age Group with Age are significant due to being categories of the same variable.

DISCUSSION AND CONCLUSIONS

Researchers assessed potential challenges and opportunities for building interest and commitment to use culinary Camelina oil in several ways. Primary findings included the following:

- Knowledge levels, beliefs, attitudes, and behaviors related to dietary fats and n-3s varied within the sample, but not to a significant degree among adults according to sex or educational background.
- Younger adults in the sample were more likely to report consuming n-3s than older adults.
- There were multiple apparent barriers for consumers likely to influence to the commercial viability of culinary Camelina oil, including:
 - Lack of awareness about the existence of Camelina oil,
 - Lack of knowledge about how to procure and use Camelina oil in culinary applications,
 - Lack of awareness about ALA or potential health benefits associated with n-3 consumption,
 - Confusion about characteristics of and recommendations for intake of different types of dietary fatty acids,
 - Demand for n-3-containing culinary oil produced organically, and
 - Lack of acceptance of the odor and taste of Camelina oil consumed straight or combined with a buttery spread (outright as well as compared to olive, Canola, and flaxseed oil), especially among younger consumers.

- Promoting widespread Camelina oil consumption will likely require cleverly and efficiently directed marketing strategies, such as integrating it into convenient products with acceptable sensory characteristics, differentiating products based on production in Montana (and possibly FA profile, chemical stability, or organic production), and employing multiple information channels to educate potential consumers about product availability, qualities, and uses.

Sensory Evaluation

Several findings from the sensory evaluation portion of the study merit additional consideration. First, the lack of consensus about preferred culinary oil appearance may indicate lack of experience with straight oils or customary use of a specific type of oil (e.g., olive). Several participants commented on being reminded of other liquids that, through association, made one or more of the samples less appealing. Others based their ratings on perceived naturalness of various colors. The range of meanings and associations attributed to the different sample colors and in some cases, consistency/viscosity, may call for a footnote on bottles indicating natural coloring (should Camelina oil be sold in pure form).

Consumers consistently recognized but did not generally enjoy the relatively strong odor of the Camelina oil-containing samples compared to the others. This may have reflected lack of familiarity with such an odor compared to that of olive oil, or perhaps preference for a lack of odor such as that characteristic of deodorized Canola oil

Participants tended to perceive Camelina and olive oil as stronger in flavor than Canola and flaxseed oil, and samples containing the former two thus typically elicited more criticism.

Although olive oil acceptance was significantly higher in several instances, certain participants in each age group also expressed disgust about samples containing it.

Interestingly, there appeared to be a more significant age-based effect for sensitivity or acceptance of the odor and taste of Camelina oil. Some of this might be attributable to reduced overall sensory sensitivity in adults, but biases and associations between less refined oils and nutritiousness may have played roles as well. On one hand, exposure to the appearance, odor, and taste of straight oil samples during the first three tests may have sensitized evaluators to the distinctive sensory properties of the four oils, influencing assessments in subsequent tests. For younger participants less aware of the circumstances in which the study was taking place, detection of the unfamiliar odor or taste of Camelina oil seemed to elicit negative responses. The comment “194 (a Camelina-containing vinaigrette sample) has the gross stuff in it!” is illustrative. Conversely, adult members of the Bozeman community more familiar with efforts to develop Camelina agriculture in Montana may have favored samples they perceived as containing Camelina. Such favor could have stemmed from rumored healthiness of Camelina oil or interest in supporting Montana agriculture. If present, such a bias would presumably have bolstered scores given to samples containing Camelina and flaxseed oil. This presumption is based on perceived evaluator confusion between the two due to appearance similarities and lack of familiarity with the oils’ specific sensory properties.

Beliefs about the healthiness of less refined oils may have also biased evaluations of unrefined Camelina oil samples. In a recent short-term study by Covas et al, healthful effects on high-density lipoprotein (HDL) cholesterol and oxidative stress markers were greater for extra virgin olive oil compared to a pair of more refined olive oils.⁵⁵ The authors believed the

differential effects were related to removal of phenolic compounds during refinement. While such substantive evidence is just emerging, nutrition authors such as Udo Erasmus have asserted that refinement reduces oil healthiness for many years.⁵⁶ Evaluators sharing such views may have been predisposed to prefer samples that appeared less refined (e.g., those stronger in flavor or odor).

Preference for Canola oil-containing samples in the bread spread test seemed to indicate that significantly altering the flavor of Smart Balance® Buttery Spread may be problematic. Addition of Camelina, olive, or flaxseed oil may have introduced flavors perceived as unlike that of butter itself, reducing acceptance among evaluators expecting a butter-like product. If real, this phenomenon might indicate efforts to integrate Camelina oil into butter or butter substitutes to be unwise, unless product developers can find a way to neutralize the oil's flavor through processing or other methods.

The combination of vinegar and oil (as well as garlic, salt, sugar, and black pepper) in the vinaigrette dip tests yielded a number of interesting responses from participants. There was much less overall agreement about the strength of different samples' flavors. For some, the vinegar taste may have penetrated most when combined with the relatively neutral Canola. For others, the flavor of olive, Camelina, or flaxseed oil may have potentiated the effect of the vinegar. Alternatively, some of the samples may have contained a higher proportion of vinegar than others due to ingredient separation occurring during pouring into sample cups. Meanwhile, reported distaste for celery among several participants may have reduced their abilities to thoughtfully assess the sensory qualities of the vinaigrette samples.

As in previous tests, adults were less likely to detect significant taste differences between samples. While several wrote that all the samples were either palatable or pleasant, younger

evaluators more often commented specifically about those containing Camelina oil, with assessments ranging from “really sweet” to “funky” to “nasty.” Regardless, the high school-aged evaluators rated the Camelina vinaigrette acceptable overall, in contrast to their perceptions of Camelina oil-containing samples on the other tests. Since many adult eating patterns develop during childhood,⁴⁹ this could indicate particular marketing potential of unrefined Camelina oil as an ingredient in a pre-made vinaigrette, as younger consumers might be willing to consume it along with adults. On the other hand, younger evaluators typically rejected Camelina oil-containing samples on the other tests. Unless product developers can alter the sensory characteristics of products like straight unrefined Camelina oil, they may not be well-received unless marketed primarily to adults.

Flaxseed oil, due to its estimated 50% ALA content, is the culinary oil on the market most comparable to Camelina oil, and would likely be its primary competition. Neither of these oils is suited to frying applications, based on reported oxidation (presumably of ALA) at cooking temperatures.⁵⁷ There may be potential for use of Camelina oil in cooking under anaerobic conditions such as those occurring during baking of leavened bread,⁵⁷ since these may prevent oxidation and associated formation of products with “off” flavors. Otherwise, Camelina oil appears best suited to cold culinary applications such as (but not limited to) the preparations described herein. Meanwhile, researchers did not explore the possibility of infusing Camelina oil with ingredients such as garlic (absent vinegar) to determine if that would increase consumer acceptance in bread dipping applications.

The sensory evaluation results did not indicate significant differences between acceptance of Camelina and flaxseed oils among adults in vinaigrettes, an application believed to be typical for current flaxseed oil consumers. Others currently consume flaxseed

oil in gel capsules and smoothies, and possibly as a topping to vegetables or pastas in place of butter or margarine. Additional research is necessary to determine consumer acceptance of Camelina oil in these specific applications, although it is likely that consumption in gel capsule form would not be subject to influence by consumer sensory perceptions of straight unrefined oil.

Focus Groups

The focus groups generated a number of ideas, concerns, and additional questions for researchers. Perceptions (or lack thereof) of current fat intake recommendations suggest a need to consider their current use and intended effects. For nutrition professionals and policy developers, being aware of current nutrient intake levels can be useful for gauging need for interventions among certain populations or assessing impacts of promotional campaigns like the 5-a-Day program for fruits and vegetables. The concept of obtaining a certain percentage of total energy from fat, in general or from a specific type, seems of limited utility to consumers, however. Determining compliance with such recommendations might require measuring or estimating food intake over several days. Most consumers would likely perceive such a task as annoying and not worth the effort.

Regardless of how obtained, the dominant perception about existing dietary recommendations seemed to center on people being “supposed to” engage in specific nutritional behaviors. In perceiving recommendations as obligations (rather than opportunities, for example), consumers may not find them particularly appealing. Tailoring health messages such as dietary recommendations in a manner eliciting different psychological responses, if possible, could enhance their implementation. Possible

alternatives might involve sharing ideas for (rather than prescribing) “foods to include” on a daily basis or “super substitutions” to increase food nutrient density or other qualities.

Consideration of relative fat quality typically reflected dualistic perceptions of good/healthy and bad/unhealthy fats. In addition, comments about health effects associated with fat intake rarely involved consideration of intake level. These simplistic views may be common even among relatively knowledgeable consumers. Thus there is an apparent opportunity to develop new ways of describing fats (and likely other dietary components as well) to encourage more sophisticated perspectives on how they can effect health and fit into the diets of athletes and others interested in promoting health and performance. Without such perspectives, information about balanced intakes of different types of fat may confuse many consumers.

Excepting *trans*-fats, each type of fat appears to have a range of health-promoting intake levels. Unsophisticated perceptions of types as “healthy” or “bad” likely helped bring about comments during the focus groups such as “I’m confused on the omega-3 and the omega-6s and the difference on why one is good and one might also be good or not good.” In response to viewing existing recommendations for saturated and n-3 fat intakes, another participant asked “what makes you want to have more saturated fat than omega-3?” Such confusion may frustrate consumers who are interested in developing and maintaining health-promoting lifestyles. In other instances, new health messages viewed as conflicting with others presented in a context of black and white nutritional “rules” might lead sufficiently fed up consumers to stop listening entirely.

Other findings indicated potentially significant gaps in consumer nutritional knowledge. None of the focus group participants could specifically describe n-3 metabolism, and several

attributed to n-3s positive health outcomes not currently associated with their intake (e.g., an ability to “catch free radicals”). Such false generalizations about various nutrients’ health effects are likely common, as seen in the research by Levy et al on consumer interpretation of food health claims.⁴³ Next, few participants could describe the structural differences between different types of fatty acids according to saturated and unsaturated bonds or (for n-3s) food source. Only one participant indicated some awareness of differences in metabolism of n-3s found in plants (ALA) and those in fish oil (EPA and DHA). Others presumably perceived these sources as nutritionally equivalent. Use of the term “hydrogenated” but not “partially-hydrogenated” for describing sources of *trans*-FAs similarly indicated confusion about fat processing methods and products. *Trans*-fats result from partial hydrogenation and contain an “unsaturated” carbon-carbon double bond in the linear *trans*- configuration, and thus differ both structurally and in health effects from fully hydrogenated fats (which contain no carbon-carbon double bonds).⁵⁸

Knowledge gaps, like unsophisticated perspectives of fat quality, may promote consumer frustration and cynicism about nutritional information and its sources. Some might conclude Nutrition Facts panels to be misleading based on content of information seemingly in conflict with that in the ingredients list. For instance, Garretson et al reported that “incongruencies” between a claim and a nutrient considered as diagnostic of a food’s nutritional value (e.g., total fat) led to reduced perceptions of product credibility among American adults.⁴⁵ Meanwhile, the debunking of myths about n-3 health benefits might lead other consumers to question all n-3-related claims. Not recognizing metabolic differences between ALA, EPA, and DHA might produce the same result. The possibility that gaps in consumer knowledge could jeopardize efforts to develop and capitalize on consumer interest

in consuming healthier oils indicates a need for responsible education efforts from both health authorities and culinary oil marketers.

The various apparent barriers to n-3 consumption, including perceived high cost, lack of availability, lack of familiarity with sources, and perceived preparation difficulty, could indicate significant opportunities for expanding current intake levels in Montana and beyond. Such barriers may be common across different populations, as Troxell et al reported many of the same ones to have prevented increased DHA intake by mothers in a Denver, Colorado WIC program.⁵ Incorporation of oils like Camelina into products perceived as reasonably priced and easy to prepare (or else ready to eat) would likely have great appeal for those currently aware of and interested in obtaining more plant-based dietary n-3s. Effective consumer education about possible health benefits of such products could also increase the number of potential buyers by raising n-3 awareness and interest levels.

Marketing and Consumer Interest Survey

Despite the limited number of respondents, a relative consensus was apparent in terms of organic production methods motivating members of the sample to spend more for certain foods. Given that equal numbers selected “organic” and “produced with less stress on the environment,” respondents may have either equated these two items or coincidentally perceived both as important. Since characteristics such as “grown in Montana” and “high in omega-3 fats” were also popular, it is difficult to know based on this survey how consumers would respond to culinary Camelina oil grown through conventional methods but labeled with the latter two claims. Research combining sensory evaluation and the effects of use of

different labels like that conducted by Andrews et al⁴⁰ could address this possibly critical question.

Of the possible names for culinary Camelina oil, a large majority of respondents preferred “Montalina.” This may relate to this name’s clear association with the state of Montana, an apparent important marketing point (at least for in-state sales). Other names might necessitate significant marketing effort to be used successfully. “Kalyalina,” for instance, combines “kalya,” a Sanskrit word for health, with Camelina. Since potential consumers are not expected to be familiar with Sanskrit, use of this name would require explanation on packaging. Meanwhile, the name “Neurolina” makes an implicit claim about the product’s role in brain health or function. Responsible use of such a name would require the presence of strong scientific evidence that consumption of Camelina oil, or at least ALA, can have such effects. Given that such evidence does not apparently exist, this name might be an ethically questionable choice.

Dietary Fat Survey

Several of the results of this survey were unusual or revealing. The reported educational background of the survey respondents indicated a highly educated sample. A remarkable 85% had at least an undergraduate college education, compared to just 17% of adult respondents in a fat consumption survey in Italy.⁹ Their education level may have contributed to Bozeman respondents’ awareness of n-3s and other nutrients. This was at least the case for functional food awareness among adults in the 2002 IFIC survey.¹⁹

Measurement of respondents’ beliefs yielded generally consistent results. This may have reflected the selection of relatively uncontroversial statements fostering consensus.

Alternatively, commonly-held opinions may have been a function of members of the population sharing perceptions about different dietary fats possibly having diverse health effects. The largest amount of disagreement was apparent in response to the statement “most nutrition experts believe fat has no beneficial health effects.” A few (13%) of respondents did not select “disagree” or “disagree strongly.” This may have reflected experience with “experts” holding views about dietary fat contrasting with those of the professional nutrition establishment, lack of awareness about the content of recent messages about dietary fat, or confusion about the statement’s content.

Incorrect answers for the section requesting that respondents select nutrients perceived to be types of fats may have been attributable to multiple factors. Over all, very few respondents selected items that weren’t fats, perhaps indicating honest effort to complete the survey accurately. Belief that vitamin E was a fat by 14% likely stemmed from confusion between fats and fat-soluble vitamins. Meanwhile, 46% selected cholesterol, which is a lipid but does not have energy-providing potential like fatty acids. Unfortunately, there is no way to tell if respondents selected cholesterol because they associated it with dietary fat (below which it appears on the Nutrition Facts Panel) or if they interpreted the word “fat” in a general way (i.e., as equivalent to “lipid”).

Common lack of recognition that several items were fats indicated the presence of incomplete nutritional knowledge within the sample. While more than 90% of respondents correctly recognized saturated, monounsaturated, polyunsaturated, and *trans*-fats, fewer recognized n-3s (78%) and n-6s (62%), and far fewer recognized alpha-linolenic acid (24%), EFAs (16%), or the long-chain n-3s EPA and DHA (6% each). The 78% recognition level for n-3s may have indicated sample- or time-based increases in awareness levels compared to

those apparent among respondents to the 2002 ADA survey.¹⁷ On the other hand, a question on the ADA survey specifically asked if the respondents were “very familiar” with n-3s, which may have elicited negative responses from those with just vague awareness. General awareness of the main fatty acid families among the respondents likely relates to both the regular usage of terms like “saturated fat” in media and their required inclusion in the Nutrition Facts Panel. Furthermore, recent media attention and food labels (e.g., those for n-3-containing eggs) have likely highlighted the roles and presence of n-3s but not n-6s, so the difference in their recognizability also seems reasonable.

A large majority (76-94%) of respondents were unaware that the names alpha-linolenic (acid), EFAs/essential fatty acids, DHA, and EPA are names of fats. This finding likely points to largely unsophisticated understandings among non-nutritionists about types of fats beyond the main familial classifications. It could also imply a need to educate consumers about types of n-3s and the strengths of research associations between their consumption and health effects. This might reduce misperceptions about their varied roles in promoting health. For instance, in a double-blind, placebo-controlled study, Mori et al associated significant reductions in 24-hour blood pressure and heart rate among mildly hyperlipidemic men with consumption of 4 g/d DHA but not EPA or olive oil.⁵⁹ Meanwhile, ALA can be converted to EPA and DHA in the liver through a series of desaturation and elongation reactions.⁶⁰ Endogenous DHA formation is limited, however, such that significantly enhancing DHA levels through ALA intake alone (as opposed to through consumption of pre-formed DHA in fish, fish oil supplements, or algae-derived DHA supplements) does not appear possible.⁶¹ Therefore, expectations of similar health effects from consuming ALA (e.g., in Camelina) or EPA and DHA (e.g., in fish oil) would be unreasonable.

Reported reasons for buying or eating particular foods likely reflected certain beliefs and attitudes. “They keep me healthy” was the most commonly selected reason (94%), followed closely by “they taste good” (89%). The former result seems to indicate a near consensus of opinion in the sample about a significant food-health link. Such was not apparently the case among 1994-1996 DHKS respondents, just 62% of whom believed foods could significantly impact chronic disease risk.²¹ Meanwhile, the role of taste as a major influence of food choice is in agreement with the findings of numerous researchers, such as those of Tuorila et al in regard to consumption of milk, cheese, and ice cream.⁴⁸

Responses to the question about n-3 intake frequency may have indicated a group of consumers within the sample population with limited n-3 awareness levels. In comparison to the inability of 22% of respondents to correctly identify n-3s as a type of fat, 33% selected “I don’t know” to describe their intake frequency. This left 11% who were apparently knowledgeable enough to know what n-3s were but not where they were found in the food supply. In some cases respondents may also have had poor recall of foods consumed and selected “I don’t know” for that reason. Others, meanwhile, may have simply guessed about their intake frequency or incorrectly calculated it based on misperceptions of n-3 food sources.

Overall, the 25% of respondents who apparently consumed n-3s on a daily basis (i.e., most habitually) might represent a group of people who would be inclined to integrate an additional n-3-containing product into their diets, either to supplement their current intake or to replace another source (e.g., flaxseed oil). In addition, marketing efforts might target consumers like the 30% of respondents who were apparently consuming n-3s 1-5 times per week. Effective marketing information (e.g., about n-3 sources and health effects) might

induce more frequent (e.g., daily) consumption by such consumers, or else might encourage those represented by the 33% who selected “I don’t know” to begin consuming n-3-containing (e.g., from Camelina oil) products.

Responses to the question about shopping frequency provided some understanding of respondents’ food purchasing roles. A reported 70% shopped for food multiple times per week, which may or may not have implied that they were primary shoppers for their households. This finding is suggestive that the majority of respondents regularly patronized food stores, but the question did not allow for identification of specific stores in which product placement might maximize access among consumers aware of or interested in n-3s.

The responses to the items about information use and interest may indicate strategic channels for n-3 education and product marketing. Common (among 50%) reliance on friends for nutritional information may call for promotions likely to increase conversations about n-3 sources and health effects. Just 14% of ninth graders in Rhode Island reportedly obtained information about n-3s from friends.²⁰ Such a difference in strategies for obtaining information likely relates to increasing interest/concern about health and changes in conversation topics as people age.

Generating interest among writers of magazine articles might be another effective marketing tactic. Twenty-eight percent of respondents wrote in “magazines” as a current information source. Due to the lack of inclusion of magazines among the sources provided as choices on the survey, this figure is likely an underestimation of actual magazine use, which was reportedly 39% in Minnesota among readers of “ecolabels.”²³

While use of schools for nutrition education was reportedly just 10%, 30% of the adult respondents sought more school-based information. There thus may be potential for college

cafeteria-based promotions for raising overall nutritional and n-3 awareness or involving parents in secondary school nutrition education programs. Meanwhile, the 30% of respondents seeking more internet-based information would likely be amenable to accessing informative websites or receiving tailored e-mailed messages.

Despite the presence of a handful of significant correlations related to demographic sub-groups, the statistical analysis of the Dietary Fat Survey mostly indicated sample homogeneity. The most statistically significant correlation was between ALA recognition and knowledge score, which more than anything indicated agreement between these measures of respondents' knowledge. There was also a strong tendency for younger respondents to consume n-3s more than their older counterparts. An age-group-based effect was not apparent as in findings reported by Childs et al, however.²² Specifically, reported use did not appear to be greatest among respondents in the sample between ages 35 and 65.

The significant, negative correlation between male sex and n-3 intake, although only when counting "I'm not sure" answers as no intake (denoted n3YNM), may indicate greater n-3 consumption by women in the sample. On the other hand, the significant, negative correlation between education level and the same measure of n-3 intake is difficult to explain. One or both of these results may have been a function of the effect of assuming "I'm not sure" answers to indicate no regular intake rather than indicating an actual relationship. This possibility is suggested by the lack of significant findings for comparisons of sex and education level to n-3 intake when excluding "I'm not sure answers" (denoted n3YN).

Study Limitations

Each of the major study components involved certain limitations. Some related to the exploratory nature of the research and “20/20 hindsight.” Others were difficult to avoid based on limited human and equipment resources.

Sensory Evaluation

The sensory evaluation tests had several limitations. First, the order of tests may have introduced bias in favor of or in opposition to samples containing Camelina, depending on evaluators’ ability to recognize its unique color (although similar to that of flaxseed oil), odor, and taste, as well as their awareness and interest levels about the oil. Evaluators were also stationed individually but not privately. This created potential for bias due to communication of feelings about certain samples. Such communicatory bias was most likely among college group evaluators, who were seated at large tables and in some cases, facing one another.

The evaluators were all associated with a local cross-country ski club, which may have predisposed them to greater-than-average attention to health and food quality. This reduced the generalizability of findings to other populations (e.g., all Bozeman adults). Evaluation by just 45 people, of whom 18 were adults, also limits the meaningfulness of the overall and age group-specific findings. Ideally, hedonic tests of new foods involve 75 to 150 regular consumers of the product (for reformulations) or an existing competitor.⁵⁰

Failure to collect demographic information about evaluators limited the utility of the sensory data. For example, this prohibited researchers from testing for age-based (rather than simply age group-based) and sex-based correlations with evaluations.

The specific choice of sample preparations may also have influenced results. Researchers selected simple combinations of ingredients in order to manage study logistics as well as to generally preserve the sensory characteristics of the base oils. Inclusion of additional spices or alternative combinations (e.g., oils with butter rather than Smart Balance® buttery spread) may have changed acceptance scores on tests involving multiple ingredients.

The form of Camelina oil used was likely less refined or possibly pressed under less controlled conditions than those used to produce the other oil samples. Greater refinement or more controlled production conditions (e.g., meticulous removal of weeds or other potential contaminants prior to pressing) could have reduced the Camelina oil's pungency or flavor potency.

Straight oil flavor tests have limited applicability to actual culinary oil uses. Researchers included one based on strong precedent for such sensory evaluation methods in the field of food science.⁶² In practice, consumers invariably combine culinary oils with other foods prior to consumption. Thus, the results of this test, which indicated poor acceptability of Camelina compared to the other oils among high school and college-aged consumers, should not by itself preclude marketing the oil in straight, unrefined form.

Completion of the sensory evaluation tests also likely involved a greater degree of awareness of odor than everyday culinary oil use. Researchers did not seek to determine if consumers would detect the odor of unrefined Camelina oil during typical food preparation, or if such detection would detract from or preclude this kind of use.

Focus Groups

Conducting the focus groups involved several limitations as well. First, the moderator knew several of the participants prior to the study, and most were aware of his nutrition education background. They thus tended to interact with him as an expert, in many cases asking questions rather than simply providing ideas and opinions. Lack of experience in the role may also have limited the moderator's effectiveness in promoting a comfortable, non-judgmental atmosphere, possibly discouraging certain participants from contributing ideas and opinions.

Part way through the focus groups, participants received significant amounts of information about types of fat (including n-3s), food sources, and perceived health effects of appropriate and inappropriate relative intakes of different fats. Researchers shared this information to assess consumer reactions to it, including their abilities to process it immediately. Since the participants apparently considered the moderator to be a trustworthy expert, the information likely influenced their perceptions of Camelina oil "credence characteristics."¹⁰ Measuring the extent of this influence and other information-based effects on interest in consuming Camelina oil-containing products would have required administering a pre- and post-test of such interest. Researchers did not do so. Meanwhile, responses to the last three questions (relating to barriers to n-3 consumption, facilitators of it, and personally viable approaches, respectively) were undoubtedly influenced by this information. Without a measurement of the extent or nature of the influence, there is no way to know how relatively uninformed consumers from the sample population would have responded. This limits the significance of the responses to these questions in terms of characterizing current interest in n-3- and Camelina-oil-containing products.

Marketing and Consumer Interest Survey

As with the focus groups and Dietary Fat Survey, the sample of respondents to the Marketing and Consumer Interest Survey was non-randomly selected and unique in its composition. Respondents were likely those from the adult focus groups most motivated to support Camelina development. They thus had different perspectives about the oil than other potential area and Montana consumers, never mind those from outside the state. In addition, the small sample size of 12 calls for general caution in interpreting results.

Dietary Fat Survey

Administration of this survey involved several additional limitations. Researchers used a non-random convenience/quota sample of Bridger Ski Foundation Club members and attendees at a club pot luck. Generalization of results to larger populations (e.g., Montana adults) would thus be imprudent. The total sample size of 63 was also limited, as was collection of demographic data for just 38 respondents.

Selection and wording of certain questions caused confusion, necessitating their exclusion prior to data analysis. In other cases interpreting results was difficult for researchers based on multiple possible interpretations of questions by respondents. In retrospect, administration of the survey to a small test group prior to doing so on a larger scale could have enabled researchers to better identify problematic items and alter them in order to minimize respondents' confusion and the possibility for multiple interpretations.

It is difficult to assess the importance of various attitudes in influencing consumer behaviors based solely on survey data. People may in fact be unaware of the influence or

presence of certain attitude-related factors.⁶³ Identifying such factors typically requires combined surveying and behavior testing.

Additional Note

Certain factors likely to influence the marketability of culinary Camelina oil are subject to uncertainty. Should product differentiation focus on n-3 content, marketability could hinge on the research results of studies of ALA consumption. Lack of clearly elucidated mechanisms or strong evidence that long-term significant ALA intake (e.g., more than 2 grams per day) has net beneficial health effects calls for caution among product marketers. The FDA currently allows a “qualified health claim” on food labels relating n-3 intake to reduced risk of coronary heart disease.⁶⁴ Manufacturers of conventional foods and supplements containing EPA and DHA are permitted to include the claim on product labels. However, products containing only ALA cannot carry the claim. In light of the uncertainty of the future of ALA consumption research findings and other factors related to consumer demand, differentiation strategies related to production location and methods appear warranted. Continuing to develop non-culinary applications for Camelina oil use (e.g., as a biodiesel fuel) would further reduce risk for farmers and producers. This could be especially true in the event of discoveries of any harmful effects of considerable long-term ALA or Camelina oil intake.

Conclusions

There appears to be a group of consumers in the Bozeman area who either currently consume products containing n-3s or are interested in doing so. Effectively marketing

Camelina oil-containing products to such consumers could promote commercial viability of the oil. The presence of n-3s in food products is apparently one of several characteristics capable of influencing interest in, willingness to pay more for, or actual consumption of Camelina. Other pertinent characteristics likely include organic production and in-state cultivation.

Based on sensory evaluation results, the distinct “grassy” odor and taste of straight, unrefined Camelina oil may be a barrier to acceptance. On the other hand, there is apparent interest in products containing Camelina oil, including (but not necessarily limited to) vinaigrettes, nut butters, hummus, and baked goods. Clever combination of ingredients in developing such products could sufficiently conceal or complement the oil’s distinct sensory characteristics. Alternative means of addressing this potential barrier could include refining the oil to some extent or eliminating potential contaminants (e.g., weeds) prior to pressing.

Regardless of the choice of product form(s) ultimately made available to consumers, consideration of certain marketing principles should promote Camelina oil’s commercial success. Palatability is a must, based on the findings of numerous sensory studies. In a review on functional foods, Nancy Childs writes that taste, convenience, and value are the most important factors in food introduction success.⁴¹ Meanwhile, in the case of fat spreads, Bower et al positively associated purchase intent with “liking” as well as price- and health-related label information.³⁶

Appropriate market segmentation and targeting of consumers is crucial as well. Childs describes the profile of consumers with a predisposition to foods perceived as likely to enhance health as “female, well educated, higher income, in a broad 35-55 age group, and actively interested in... health,” as well as being “community-focused” and perceiving “a

more holistic state of total health.”⁴¹ These characteristics describe certain members of the study sample as well as the Greater Bozeman population. They might also guide Camelina market segmentation and specific product differentiation strategies.

Differentiating Camelina oil-containing products will be critical. Based on the expected role of mental heuristics in influencing purchase decisions, marketing might highlight organic or in-state cultivation. Selection of a name like “Montalina” (or, alternatively, Montanalina, which was not tested) might especially promote local production-based differentiation. Consumers quickly associating Camelina oil-containing products with positive images of community or agricultural health would likely be especially motivated to buy them.

Differentiating Camelina oil-containing products based on n-3 content could be ethically problematic. Most consumers appear unaware that there are different types of n-3s, or that non-transgenic plants like flax and Camelina only contain ALA. Few likely further recognize the reported important differences in health effects from consuming ALA versus EPA and DHA. Marketing Camelina oil-containing products as high in n-3s could lead consumers to reduce their intake of sources of EPA and DHA, based on the assumption that they were already meeting their n-3 needs. This could discourage the effectiveness of certain dietary regimes dependent on the unique health effects of the longer marine- or algae-derived n-3s.

Appropriate application of these marketing principles would likely help in overcoming the multiple apparent barriers to Camelina consumption. Pricing competitive with that of commercially available flaxseed oil, organic cultivation of straight oil (if marketed as such), development of products considered convenient to target consumers, and placement in stores frequented by such consumers could each play significant roles as well. In addition,

educating consumers in a responsible manner about the apparent health effects of ALA and other fats should increase interest in Camelina oil-containing products. Finally, providing consistent information through multiple channels, including media and in-store promotions, would likely help generate more knowledgeable (and ultimately loyal) consumers.

Additional Research Needs

This exploratory research described herein uncovered a number of potential areas for additional examination of consumer n-3-related behaviors and culinary Camelina oil. The independent forms of data collection and cross-sectional nature of the project did not facilitate linking of certain theoretical variables. Other studies might include comparisons of sensory evaluation results (i.e., “liking,” an attitude) to evaluator n-3-related beliefs or knowledge, including specific awareness of Camelina development efforts. Repeated measures of knowledge, beliefs, attitudes, and behaviors might also test the applicability of this project’s underlying theoretical framework. For instance, researchers could measure the effects of a change in ALA awareness on flaxseed oil consumption behaviors (or those for Camelina oil, were it commercially available).

Another area of critical need is measurement of actual demand for culinary Camelina oil. Commercial viability will be difficult to achieve unless there are already a sufficient number of consumers looking for locally-produced or ALA-containing product alternatives (e.g., to flaxseed oil). A demand assessment would likely involve surveying a larger sample of potential consumers to determine current n-3-containing product use and attitudes related to potential Camelina-based products. Willingness to pay certain prices for specific products would likely be one appropriate target for attitude measures. Another could be the effects on

purchase intent of producer and vendor ownership form (e.g., cooperative or corporate) and size (e.g., local, state-wide, or multinational).

Additional assessment of consumer attitudes should include means for comparing their reported and actual influence on behaviors. For instance, Lobb et al reported a prevalence of supportive attitudes toward local food production and sales among English adults, but much lower apparent consumption.²⁴ Not accounting for such potential disparities between attitudes and behaviors could lead to overestimation of consumer demand for Camelina-containing products.

Demand assessment could also involve determining behaviors within a target population regarding home-made, home-assembled, pre-prepared, or restaurant food. While Dietary Fat Survey respondents did not appear to frequent restaurants, researchers did not assess consumption of pre-prepared foods. Marketing culinary Camelina oil in pure or vinaigrette form might be more strategic if target consumers typically prepared their own foods. Otherwise it would make sense to sell to food services, restaurants, or manufacturers of prepared foods (e.g., Stouffer's®).

Additional sensory evaluation research could yield greater insights into Camelina acceptance among target market segments by involving only regular consumers of products being tested. Researchers did not inquire about or otherwise measure dietary fat behaviors among the participants in the sensory evaluation portion of the study. Regular consumers of pure culinary oil (and flaxseed oil in particular) would be ideal participants of sensory evaluation studies involving simple preparations such as those described herein. Meanwhile, consumers who purchase commercially prepared vinaigrette products would be ideal participants in additional sensory evaluation studies about vinaigrette applications, should

marketers choose to focus on selling Camelina in this way rather than in pure form directly to consumers. Such would also be the case should marketers seek to introduce as-of-yet untested Camelina-enhanced or -based nut butters, hummus, or baked goods. Involving panels of regular consumers of a given category of food in sensory evaluation studies involving a specific food is a regular practice in the food industry,^{50,65} and thus would be an ideal research protocol.

Use of Camelina oil in baked goods or other cooking applications may necessitate more than just sensory evaluation research. PUFAs can oxidize when heated, yielding multiple products with potentially adverse health effects.⁶⁶ Some of these products appear well absorbed in the intestine, increasing the risk of harm.⁶⁷ Importantly, at temperatures above 180 degrees Fahrenheit, oxidation products do not typically produce “off” odors or flavors like those associated with rancid oils.⁶⁸ Chemical analysis to detect oxidation products in Camelina oil-containing foods cooked in various ways would promote awareness of the oil’s susceptibility or resistance to oxidation during cooking. The results could guide marketing approaches and recommendations for use (should it be sold in straight form).

Lastly, additional research about the long-term health effects of significant ALA intakes (2 grams per day or more) would promote appropriate culinary Camelina oil marketing. Initial examination of the health effects of Camelina oil consumption among various groups of people would be similarly helpful. Increased understanding in this area could facilitate eventual use of FDA-approved health claims for ALA-containing foods. If evidence for significant health benefits failed to materialize, it could call for focusing on Camelina production for biodiesel applications or differentiation of Camelina oil-containing food products based on qualities other than ALA content.

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APPENDICES

APPENDIX A

DIETARY FAT SURVEY

Instructions: please read each item carefully and answer to the best of your ability.

1. All fats in foods have basically the same effects on health. (circle one)

Strongly disagree Disagree Neutral Agree Strongly agree

2. Some types of fats are healthier to eat than others. (circle one)

Strongly disagree Disagree Neutral Agree Strongly agree

3. Most nutrition experts believe fat has no beneficial health effects. (circle one)

Strongly disagree Disagree Neutral Agree Strongly agree

4. Eating sufficient amounts of certain fats is important for good health. (circle one)

Strongly disagree Disagree Neutral Agree Strongly agree

5. Check any of the following that you think are types of fats:

- | | | |
|--|---|--|
| <input type="checkbox"/> Fiber | <input type="checkbox"/> Carbohydrate | <input type="checkbox"/> DHA |
| <input type="checkbox"/> Zinc | <input type="checkbox"/> Omega-6s | <input type="checkbox"/> Protein |
| <input type="checkbox"/> Monounsaturated | <input type="checkbox"/> Sodium | <input type="checkbox"/> EFAs |
| <input type="checkbox"/> EPA | <input type="checkbox"/> Alpha-linolenic acid | <input type="checkbox"/> Saturated |
| <input type="checkbox"/> Ascorbic acid | <input type="checkbox"/> Vitamin E | <input type="checkbox"/> Cholesterol |
| <input type="checkbox"/> Omega-3s | <input type="checkbox"/> <i>Trans</i> - | <input type="checkbox"/> Polyunsaturated |

6. Why do you buy or eat certain foods? (check all that apply)

- | | | |
|--|---|---|
| <input type="checkbox"/> They keep me healthy. | <input type="checkbox"/> They are quick and convenient. | <input type="checkbox"/> I can afford them. |
| <input type="checkbox"/> They taste good. | | <input type="checkbox"/> Other: |

Where do you currently obtain nutritional information (if applicable; check all that apply)?

- Television
- Parents
- School
- Friends
- Traditional health practitioner(s) (e.g., doctor)
- Alternative health practitioner(s) (e.g., acupuncturist)
- Internet (please specify) _____
- Other (please specify) _____

Where would you like to find more nutritional information (if applicable; check all that apply)?

- Television
- Parents
- School
- Friends
- Traditional health practitioner(s) (e.g., doctor)
- Alternative health practitioner(s) (e.g., acupuncturist)
- Internet (please specify) _____
- Other (please specify) _____

APPENDIX B

DIETARY FAT SURVEY RESULTS

Note: total numbers of responses are indicated in parentheses.

1. All fats in foods have basically the same effects on health.
 34 out of 63 participants (54.0%) strongly disagreed with this statement, and 28 (44.4%) disagreed with it.
 98.4% either strongly disagreed or disagreed with this statement.
2. Some types of fats are healthier to eat than others.
 35 out of 63 (55.6%) strongly agreed with this statement, while 38.1% agreed with it.
 93.7% either strongly agreed or agreed with this statement.
3. Most nutrition experts believe fat has no beneficial health effects.
 28 of 63 (44.4%) strongly disagreed with this statement, while 27 of 63 (42.9%) disagreed with it.
 87% disagreed strongly or disagreed with this statement.
4. Eating sufficient amounts of certain fats is important for good health.
 36 of 63 (57.1%) agreed strongly with this statement, while 24 of 63 (38.1%) agreed with it.
 95.2% either strongly agreed or agreed with this statement.
5. Check any of the following that you think are types of fats:

Fiber, zinc, ascorbic acid, protein,	Alpha-linolenic (23.8%)
sodium (0%)	Omega-6s (61.9%)
Carbohydrate (1.6%/1 respondent)	Omega-3s (77.8%)
Vitamin E (14.3%)	Monounsaturated (90.5%)
Cholesterol (46.0%)	<i>Trans</i> - (90.5%)
EPA (6.3%)	Polyunsaturated (95.2%)
DHA (6.3%)	Saturated (96.8%)
EFAs (15.0%)	
6. Why do you buy or eat certain foods?
 - They keep me healthy (93.7%)
 - They taste good (88.9%)
 - I can afford them (65.1%)
 - They are quick & convenient (42.9%)
 - Other (3.2%): food color, sports-specific for races
7. How often do you consume foods reported as high in omega-3s?
 - A. I don't know (33.3%)
 - B. <once/wk (9.5%)
 - C. 1-5 x/wk (30.2%)
 - D. Daily (25.4%)
 - E. >once/d (3.2%)

Background Information

Age: mean 46.45 yrs, range 22-67

Sex: 20 male, 18 female

Educational history

High School (2.5%)

High school grad (0%)

College (12.5%)

College grad (32.5%)

College advanced degree (seek/received) (52.5%)

Number of times shopping for food per week

None (10.0%)

0-1 (20.0%)

2 (32.5%)

3 (17.5%)

More than 3 (20.0%)

Current sources of nutrition information

Television (17.5%)

School (10.0%)

Traditional health practitioner (27.5%)

Alt health practitioner (22.5%)

Parents (20.0%)

Friends (50.0%)

Internet (20.0%)

Other: magazines (11/27.5%), labels (4), books (5), nutritionist, Co-Op bulletin, professional journals (2), spouse (2), pastor (1), health store, newspaper (2)

Sources of desired more nutritional information

Television (25.0%)

School (30.0%)

Traditional health practitioner (27.5%)

Alt health practitioner (12.5%)

Parents (10.0%)

Friends (17.5%)

Internet (30.0%)

Other: spouse (2), mags (3), books, newspaper, written materials

APPENDIX C

MARKETING AND CONSUMER INTEREST SURVEY RESULTS

Note: total numbers of responses are indicated in parentheses.

1. Underline or make bold any of the following potential high-omega-3 products you would be interested in consuming once a week or more:

Nut butters (8)	Pesto (3)
Hummus (7)	Dips (1)
Clear salad dressing (6)	Mayonnaise (1)
Baked goods (6)	Alfredo sauce (0)
Spreads (4)	Other (please name): oil to use in home
Energy bars (4)	cooking, making of own salad dressings (1)
Creamy salad dressing (3)	

2. Underline or make bold characteristics of foods that currently make you or would make you willing to spend more than you would on comparable items without the specific characteristic:

Organic (11)	High in specific vitamins &/or minerals (8)
Produced with less stress on the environment (11)	High in fiber (7)
Grown in Montana (10)	Processed in Montana (6)
High in n-3 fats (9)	Brand name (1)
High in phytonutrients or other substances associated with health (8)	Other (please specify): sold at a place like the Co-Op or other locally owned store

Comments: Honestly, cost is the biggest factor, but if the price is right (close enough to normal un “_____” foods), then any of these factors other than brand name will make me pay a BIT more.

3. Underline or make bold what you consider to be the most marketable (would promote product sales without being misleading) name for culinary Camelina oil:

<u>Potential Name</u>	<u>Refers to</u>
Montalina	Montana and Camelina (9)
Kalyalina	“Kalya” is a Sanskrit word for health (3)
Nuerolina	Nuer refers to brain, i.e. “brain food” (3)
Tanalina	Montana and Camelina (1)
Camontina	Camelina and Montana, where the plant is being grown (1)
Salutina	Salut refers to health (1)
Camelina	Camelina sativa: 1 (note – write-in)
Nuerola	Nuer refers to brain, i.e. “brain food” (0)

Comments: Kalyalina, Montalina, and Camontina are okay. THE OTHERS PLEASE NO.

APPENDIX D

FOCUS GROUP QUESTION ROUTE

1. Have you read or heard anything in the last year about recommended intakes of dietary fat?
2. Have you read or heard anything in the last year about recommended intakes of n-3s?
3. What is the relationship between consuming certain types of fat and health? Please describe.
4. Do you know anything about characteristics of omega-3s and other types of fats?
5. What do you know about foods that contain omega-3 fatty acids? Do you know any?
6. What do you think currently prevents you from including any or more high-n-3 products in your diet?
7. What might prompt you to eat more high-n-3 products?
8. If you wanted to start eating n-3s or else wanted to eat more of them, how would you go about it?

APPENDIX E

SENSORY EVALUATION SCORECARDS

Note: instructions appeared at the top of each scorecard.

Instructions: Please record the sample number evaluated, then circle the number most accurately reflecting your assessment. Use sample numbers for rankings for each test and provide comments if you like.

Test 1a: Oil Appearance

Give your assessment of the appearance of each of the four oils.

	Dislike extremely			Neutral			Like extremely		
Sample # _____	1	2	3	4	5	6	7	8	9
Sample # _____	1	2	3	4	5	6	7	8	9
Sample # _____	1	2	3	4	5	6	7	8	9
Sample # _____	1	2	3	4	5	6	7	8	9

Appearance Ranking: First: _____ Second: _____ Third: _____ Fourth: _____

Comments: _____

Test 1b: Oil Odor

Give your assessment of the smell of each of the four oils.

	Dislike extremely			Neutral			Like extremely		
Sample # _____	1	2	3	4	5	6	7	8	9
Sample # _____	1	2	3	4	5	6	7	8	9
Sample # _____	1	2	3	4	5	6	7	8	9
Sample # _____	1	2	3	4	5	6	7	8	9

Smell Ranking: First: _____ Second: _____ Third: _____ Fourth: _____

Comments: _____

Test 1c: Oil Flavor

Give your assessment of the flavor of each of the four oils.

	Dislike extremely			Neutral			Like extremely		
Sample # _____	1	2	3	4	5	6	7	8	9
Sample # _____	1	2	3	4	5	6	7	8	9
Sample # _____	1	2	3	4	5	6	7	8	9
Sample # _____	1	2	3	4	5	6	7	8	9

Taste Ranking: First: _____ Second: _____ Third: _____ Fourth: _____

Comments: _____

Test 2: Flavor of Bread Dipped in Oil

Give your assessment of the flavor of the bread dipped in each of the four oils.

	Dislike extremely			Neutral			Like extremely		
Sample # _____	1	2	3	4	5	6	7	8	9
Sample # _____	1	2	3	4	5	6	7	8	9
Sample # _____	1	2	3	4	5	6	7	8	9
Sample # _____	1	2	3	4	5	6	7	8	9

Taste Ranking: First: _____ Second: _____ Third: _____ Fourth: _____

Comments: _____

Test 3: Flavor of Spreads on Breads

Give your assessment of the flavor of each of the four spreads on bread squares.

	Dislike extremely			Neutral			Like extremely		
Sample # _____	1	2	3	4	5	6	7	8	9
Sample # _____	1	2	3	4	5	6	7	8	9
Sample # _____	1	2	3	4	5	6	7	8	9
Sample # _____	1	2	3	4	5	6	7	8	9

Overall Ranking: First: _____ Second: _____ Third: _____ Fourth: _____

Comments: _____

Test 4: Tasting Vegetables Dipped in Oil Vinaigrettes

Give your assessment of the flavor of each of the four vinaigrettes on a vegetable stick (carrot or celery). Repeat the test for the other vegetable.

Vegetable: (circle one) carrot celery

	Dislike extremely			Neutral			Like extremely		
Sample # _____	1	2	3	4	5	6	7	8	9
Sample # _____	1	2	3	4	5	6	7	8	9
Sample # _____	1	2	3	4	5	6	7	8	9
Sample # _____	1	2	3	4	5	6	7	8	9

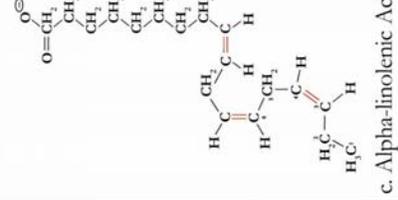
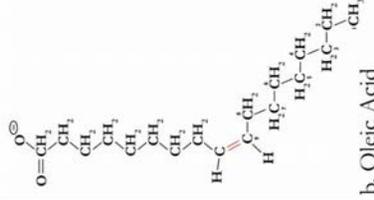
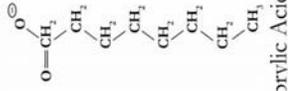
Overall Ranking: First: _____ Second: _____ Third: _____ Fourth: _____

Comments: _____

APPENDIX F

FOCUS GROUP FATTY ACID OVERVIEW HAND-OUT

Meet the Fatty Acids					
Classes & Subclasses	Structure & Properties	Examples	Typical U.S. Dietary Sources Intake	Recommendations	Balanced Intake Health Outcomes
SFAs (Saturated/Sat)	Max H (straight, stable, hard at room temp)	Palmitic acid, caprylic acid [pictured (a) at right]	11.2% kcal (25 g/d)	<10% total kcal/d (usually 20-25 g/d)	↓risk of CVD, obesity, & type 2 diabetes (DM)
MUFAs (Mono-unsaturated)	Less H (bent, liquid at room temp)	Oleic acid [pictured (b) at right]	12-14% kcal (27-31 g/d)	Up to 20% total kcal/d	↓risk of CVD
PUFAs (Poly-unsaturated)	Least H (crooked, liquid at room temp)	See below	5.4-6.8% kcal (12-15 g/d)	Up to 10% total kcal/d	↓risk of CVD, improved outcomes for rheumatoid arthritis, asthma, major depression, demetia, psoriasis, lupus nephritis, Crohn's disease, & ulcerative colitis
Omega-6 (n-6)	Less stable than MUFAs, liquid at room temp	LA (linoleic acid)	5-6% kcal (11-13 g/d)	Corn/safflower/soybean/Canola oil, sunflower seeds	5-10% kcal/d or 1-4 times the n-3 intake
Omega-3 (n-3)	Least stable/most chemically reactive	See below	0.4-0.8% kcal (1.0-1.8 g/d)	See below	Men >1.1 g/d, Women >1.6 g/d
Plant-based	Long	ALA (alpha-linolenic acid) [see (c) at right]	0.4-0.7% kcal (0.9-1.6 g/d)	Flaxseeds and oil, Camelina oil, walnuts	0.6-1.2% total kcal/d
Fish- or Algae-based	Longest	EPA & DHA (Eicosapentaenoic & Docosahexaenoic acid)	0.02-0.03% kcal (0.04-0.07 g/d)	Fatty fish (anchovy, salmon, mackerel, sardine, herring, rainbow trout)	See above
Trans (TFAs)	Straightened PUFAs, hard at room temp	Elaidic acid	2.6% kcal (5.8 g/d)	Hydrogenated oils (cakes, cookies, French fries, etc.)	↓risk: CVD, cancer, obesity, type 2 DM, ↓gestational time
Total Intake:			32.7% kcal	20-35% kcal	



APPENDIX G

FOCUS GROUP FOOD FATTY ACID CONTENT HAND-OUT

Comparing Food Fat Contents									
Fat-Containing Foods	Serving	% SFA	% MUFA	%n-6	%n-3	n6:n3	% Trans	Fat g	Cal
Whole Milk	1 cup	57.6	25.1	6.1	2.3	2.7	0.0	7.9	146
Silk Soy Milk	1 cup	12.0	20.0	35.1	4.5	7.8	0.0	3.5	100
Butter (unsalted)	1 Tbsp	63.5	26.1	3.5	0.4	8.9	0.0	11.5	102
Earth Bal. Whipped Buttery Spread	1 Tbsp	27.8	27.8	30.0	3.3	9.0	0.0	9.0	80
Wild Atlantic Salmon	3 oz	15.9	33.3	4.3	37.7	0.1	0.0	6.9	155
Cooked Ground Beef (25% fat)	3 oz patty	38.6	45.7	2.1	0.3	7.0	7.1	14.0	211
Pop Secret Homestyle Popcorn	1/3 bag	25.0	20.8	12.5	0.0	N/A	41.7	12.0	170
SmartBalance Light Popcorn	1/3 bag	33.3	33.3	31.1	2.2	14.0	0.0	4.5	120
McDonald's Med French Fries	1 container	17.8	43.3	19.4	1.1	17.5	21.1	18.0	350