FINAL REPORT

Development of Soy Saskatoon Berry Smoothie

FDC Project # 3568

Submitted to:

Manitoba Pulse Growers Association Inc.

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Executive summary

Smoothies are considered one of the most popular high end beverages in the USA and UK markets and projected to reach $9 billion by 2015 Global Industry Analysts (GIA) 2011). Smoothies have a broad definition and are mostly defined as a thick, creamy beverage composed of both fruit and dairy ingredient. A non-dairy smoothie can be made by replacing the dairy ingredient of traditional smoothies with soymilk (Nessinger, 2011).

The development of a soy-saskatoon smoothie prototype using Manitoba soy beans and small berries will allow Manitoba and Canadian consumers to enjoy a non-dairy based beverage with a rich nutritional profile. It demonstrated that value can be added to soy beans by soy milk processing and soy meal/cake processing.

To address the challenge of the beanie soy flavour, a fermentation process was considered. Fermentation is a critical process in developing the soy smoothie prototype. Several research papers reported that yogurt culture is suitable for soymilk fermentation as it can reduce both the beanie flavor of soy and anti-nutritional factors to increase digestibility. As well, the development work confirmed that regular yogurt culture in combination with other lactic acid bacteria could be used to ferment soymilk into a semi-solid curd without whey separation occurring. A soy yogurt (sogurt) was developed as an ingredient for the smoothie in this project.

The final prototype was obtained by blending soy yogurt made from defatted soymilk with juices (Saskatoon, sour cherry and black currant), gums, white grape juice concentrate and vitamin mineral premix. The final product was low in fat, low in saturated fat, high in iron, very high in calcium and it was a source of fiber. Nutritional analysis and a preliminary one month shelf-life study at refrigeration temperature were conducted on the chosen prototype.

Ten panelists evaluated the final product on the sweetness, acidity level, flavour balance, creaminess and overall acceptability on a four-point scale at FDC. The panelists described the soy-saskatoon smoothie developed in this project as having a good balance of sweetness and acidity level, smooth texture with a balanced fruity flavour.

1.0 Introduction

The selection of soy foods and beverages is ever-expanding, more innovative, nutritional and palate-pleasing in today's market. The growing awareness of the health benefits of the soybean and its unique functional properties has made soy-based products increasingly popular in the mainstream market. Soybeans are a major contributor of phytosterols to the diet, particularly β-sitosterol (90mg/100g edible portion of the soybean) (Weihrauch &Gardner, 1978). Soy products play a major role in the food chain having functional properties include emulsifying, gelling, fat-binding, texturizing and dough forming and are used in a wide variety of foods value added foods from cereals to chicken products. The consumer demand for non-dairy beverages with high acceptance and functionality has been increasing in North America. The smoothie market grew by 80% in the past five years and the USA smoothie market brings in over $2 billion in sales each year (2011 edition, http://www.smoothiestatistics.com).

Smoothies are blended drinks made from fruits, sweeteners and may contain milk, soymilk, whey powder, green tea and supplements. It has a milkshake like consistency that is thicker than ice based slush drinks. Smoothies are considered a high-end premium healthy drink which can be consumed with breakfast or a snack. Currently, soy-based smoothies are not widely accessible to consumers, and Saskatoon berry flavoured beverages are very rare product as well, so the development of a soy Saskatoon berry smoothie made with Manitoba ingredients allows Manitoba consumers to enjoy a non-dairy based beverage with a rich nutritional profile.

This project allowed the opportunity to work with Manitoba Pulse Growers Association and Manitoba Fruit Growers Association for the development of an innovative process and product for soy-saskatoon smoothie. The initial concept of the soy smoothie was to prepare soy milk from whole soy beans, blend with Saskatoon berry juice, flavourings and sweeteners to achieve a balanced beverage. The saskatoon berry has a classic prairie flavour that can be derived from further processing of the frozen berries to provide natural saskatoon flavour for the smoothie. During the literature research it was identified that defatted soy cake, a by-product of soybean oil processing is an underutilized ingredient and the Manitoba soybean industry could benefit from a value-added product application. The defatted soy cake was sourced from the Richardson Centre for Functional Food and Nutraceuticals (RCFFN) in Winnipeg was incorporated into the prototype development of a the smoothie. In addition, FDC developed a fermentation process to reduce the beanie flavour of the de-fatted soy cake and hence incorporated the development of a soy yogurt as an ingredient in the formulation of the smoothie.

The goal of this project is to develop a prototype soy yogurt saskatoon smoothie product. The regulations and health claims of GM soybeans were reviewed. The nutrition fact table for the prototype smoothie is also included.

2.0 Product Development Overview

The food and beverage market have experienced significant changes towards healthy products, especially toward smoothies. Due to these changes, customers are demanding fresher quality products, ready-to-go, exotic blends and flavours. The first trend is the healthy trend, in which customers want natural and clean labels. In the smoothie beverage, that means an increasing demand for natural fruit purees and dairy products. The second trend is for customized products, where despite healthy properties, customers demand more variety and functionality, from a number of ingredients, such as: combination of exotic fruits, as well as, vitamins and proteins; in order to make unique drinks or signature items.

The development of the soy smoothie focused on food safety, taste and nutrition to achieve a unique soy yogurt-smoothie, pasteurized and ready-to-drink (RTD) beverage. It involved researching the existing market to determine sensory attributes of smoothie beverages; evaluating and selection of suitable ingredients, developing a soy yogurt (sogurt) to mask bitterness and unacceptable soy flavours, developing product formulations for a soy-saskatoon berry smoothie with high nutritional and good sensory quality and assessing the stability of both the sogurt and smoothie products.

Market Assessment

FDC purchased samples from local grocery stores as shown in Figure 1 and conducted a sensory panel to establish the sensory profile used as the guide to the development of soy smoothie.

Figure 1: Commercial samples purchased from local store

Panellists preferred the smoothies containing flavoured yogurt with or without fruit over a soy beverage. Panellists preferred a balance of sweetness and acidity combined with a creamy texture over a beanie aftertaste of soy beverages. Analytical tests were also conducted on the

preferred smoothie brands to assess their qualitative characteristics. This includes the measurements of the brix, ph, acidity and the ratio of brix/acidity. The overall result was that panellists preferred the *ÏOGO* brand smoothie over all other brands. Appendix 1 reviews the overall data of the study.

Smoothies are marked as high-end premium product in non-carbonated soft drink sector. In recent years, fruit-based smoothies gained tremendous popularity in US and UK, and currently become one of the major soft drink markets. It is considered a developed as well as emerging market, according to Global Industry Analysts (GIA), Inc, the global smoothie market is projected to reach $9 billion by 2015, US as the dominate market with new market opening across North America and Europe. It is primarily driven by information-rich, health-aware, time-poor consumers, so creating a healthy, on-the-go consumption convenience, tasty and natural are the key elements that differentiate from other beverages. The best selling in-franchise smoothies are strawberry-banana, mixed berry, mango and tropical blends. However, the high price represents the major hindrance. Other factors that affect its growth are limited product choice, and high fat and sugar content (GIA, 2012). Formulating with defatted soy cake will take advantage on the consumer preference for a low fat smoothie.

Processing challenges and methods

Although, soy has several health benefits, the distinctive soy flavours noticed by consumers such as beanie, painty, rancid, or bitter are unacceptable in western world. In the past several decades, numerous studies have determined that the formed ketones, aldehydes and alcohols from the peroxidation of polyunsaturated fatty acids or ester catalyzed by the enzyme lipoxygenase are responsible for the undesirable beanie flavours (Wilkens et al. 1967; Wilkens and Lin 1970; Nelson et al. 1971, 1976).

To address the challenge of the beanie soy flavour, a fermentation process was considered. Fermentation is a critical process in developing the soy smoothie prototype. Several research papers reported that yogurt culture was suitable for soymilk fermentation as it can reduce the beanie flavor of soy and anti-nutritional factors as well as increase digestibility (Pinthong et al. 1980). This effect was considered in the product development and sensory analysis confirmed such findings. The choice of the fermentation substrate was considered and the review found that Pinthong et al 1980, reported that *L. delbrueckii subspecies bulgaricus* can ferment soymilk into yogurt –like product and an optimal level of 1.15% of lactic acid resulted in an improved flavor and firm curd texture without whey separation.

3.0 Formulation and Smoothie Development

The development of the smoothie incorporated

- The development of soymilk from defatted soy cake
- The development of soy yogurt from soymilk
- The development of the soy-saskatoon smoothie.

Further, FDC investigated the extraction process of soy milk from whole soy beans using a traditional Oriental method (Appendix 4) and compared the milk's creamy texture and beanie flavor against the milk prepared from defatted soy cake. In addition, a soy yogurt was made using whole milk and defatted milk to compare the variance in texture and lactic acid production, the two key critical factors in the fermentation of yogurt.

Ingredient Selection

Commercial ingredients were sourced in this project to ensure product quality consistency and the Supplier information is attached in Appendix 7.

- The fresh whole soybean, variety: HS006RYS24 was purchased from RJP Seeds Ltd, Carman, Manitoba. This variety was chosen as it is used by The Richardson Centre Functional Foods and Neutraceuticals (RCFNN) for soy oil pressing. In considering the full utilization of the soy bean for the soya oil industry the smoothie was prepared from soymilk derived from the defatted soy cake/meal (by-product of soy oil process). Defatted soy cake/meal is high in protein (42%) and fiber, but has a gritty mouth-feel and beanie flavor. These two sensory components were addressed in the smoothie through the development of a fermentation process of the defatted soy milk into soy yogurt to provide a smooth mouth feel and reduction in soy beanie flavours.
- Dried honey, and white grape juice concentrates were tested for its compatibility in the smoothie. Sensory evaluation was conducted and results can be found in result section of this report.
- Saskatoon berries were the preferred choice to incorporate a Manitoba berry into the smoothie, but it was determined that the defatted soymilk required enhanced fruity notes. A juice blend was determined to be more complementary. The juice blend previously developed by FDC in Project # 3344 was prepared for this project. It is made from frozen Saskatoon berry, sour cherry and black currant, all sourced from Manitoba growers.
- Several stabilizers were tested at different levels however, smoothies prepared from Dairyblend 850-CS from Tic Gums provided the best product suspension. Dairyblend 850-CS includes a blend of pectin, maltodextrin, guar gum and xanthan gum.
- Soy smoothie is considered a plant protein based beverage and in order to meet the Health Canada regulation must be fortified by certain vitamin and minerals. Based on

the preliminary analysis carried out on the Genesis™ database, it was necessary to add Vitamin A, D2, B2, calcium and zinc. The Vitamin Premix was sourced from Calico Food Ingredient, Kingston, Ontario. Appendix 7 details the minimum vitamins and minerals a food must have before fortification, and also provides the table of vitamins and minerals that can be added to a plant based beverage in order to fortify the beverage.

- To improve the overall acceptance, natural flavours from Metarom Neotech, Saint-Hubert, Quebec, was sourced, including wild berry flavour, Saskatoon flavour and five fruits flavour.
- The culture (Yo-Mix™Vegetal 7) used for the fermentation process was sourced from Danisco Canada Inc., Scarborough, ON. It contained mixed stains of bifidobacterium and lactobacillus to shorten the fermentation time and aid in the survival of culture at refrigeration temperature. Inulin (LV 110) powder from Tic Gums was added to the yogurt- making steps as a pre-biotic, to improve the viability of active culture.

Product Quality Testing

1. The Brix level of the smoothie was measured using a Refractometer (Model# Reichert Mark II plus) and the pH value was measured by a Fisher Scientific pH meter (Accumet®Excel XL50).
2. The total acidity and lactic acid content were measure by titrating with 0.1N sodium hydroxide. The total acidity was titrated till the pH value of 8.4 was achieved and calculated as a percentage of malic acid. The end point for lactic acid was titrated until the first pink color lasting 10 seconds was determined.
3. Sensory evaluation was conducted with 8-10 panelists, qualified as end users of this beverage. Sweetness, tartness, flavor balance, creaminess and overall acceptability were rated using a 4-point hedonic scales. Appendix 5 displays the sensory ballot.
4. Microbiological testing on shelf life samples were tested for Total Aerobic Plate Count, Yeast, Mould and E.Coli. The analytical references are:
   MFHPB-33 – Enumeration of Total Aerobic Bacteria in Food Products and Food Ingredients Using 3M™ Petrifilm™ Aerobic Count Plates
   MFHPB-32 – Enumeration of Yeast and Mold in Food Products and Food Ingredients Using 3M™ Petrifilm™ Yeast and Mold Count Plates
   MFHPB-34 – Enumeration of E.coli/Coliform Count in Food Products and Food Ingredients Using 3M™ Petrifilm™ E-coli/Coliform Count Plates

Preparation of Defatted Soy Milk

The defatted soy milk was prepared by hydrating soy cake in water using a ratio of 1Kg soy cake to 10 Kg tap water. This mixture was hand whisked to break the cake into smaller sizes then

blended with a Robot Coupe hand mixer for ten minutes at speed nine. Hydration was carried out at room temperature for 60 minutes. The hydrated mixture was again blended with the Robot Coupe for five minutes at speed nine then filtered using a Kason Sifter (40, 100 mesh). After filtering, the liquid phase or soymilk was transferred to a Colloid Mill and stone milled using 0.3mm gap for two minutes followed by 0.15mm gap for another two minutes to reduce its particle size and to obtain a creamy texture. The total solids content was measured in ^{0}Brix (^{0} Bx) using a MarkII Plus Refractometer (Reichert, USA) before heating. The soymilk was heated at 82-85^{o}C for five minutes and packaged in pails until ready for use. The detailed evaluation on the soymilk was attached as Appendix 2.

Preparation of Soy Yogurt

Table 1: Formulation of soy yogurt

Ingredient	%
Soy milk	90.89
White grape juice concentrate	5.45
Soy milk powder	1.55
Inulin	2
Flavor	0.1
Culture	0.01
Total	100

Table 1 above, displays the ingredients and formulation used in the preparation of soy yogurt. Soymilk powder and inulin were added to the defatted soymilk and mixed well in a double boiler. This was heated at 90-95^{o}C for 20 minutes and stirred occasionally to prevent protein burning at the bottom of cooking utensil. A total solids content of this soymilk mixture was targeted between 14-16%. At the same time, white grape juice concentrate was pasteurized at 65^{o}C for 20 minutes on a hot plate. Stirring was also needed. After concentrating the soymilk, natural flavour was added during the last minute of heating to enhance its overall flavour. Heating of the soymilk not only helps the reduction and/or elimination of microorganisms, but also aids in protein coagulation to form a good yogurt. Grape juice concentrate was added to the soymilk mixture then cooled to 42^{o}C in an ice bath. The freeze dried live culture (Yo-Mix™ Vegetal 7) was added and stirred until fully dissolved. To reduce the chance of contamination, only sterilized utensils were utilized. The soy yogurt base was incubated in the Rational Oven at 43^{o}C for 7-8 hours or till the pH value of 4.4-4.6 was achieved. The temperature was chosen based on the supplier's instruction, which is a more common practice in industry to accelerate the fermentation process, and to increase the yogurt making productivity. During fermentation, the total solids

content, brix level of raw soymilk, lactic acid content and pH value were monitored. After fermentation, soy yogurt was stored in the refrigerator until ready to use. The detailed evaluation on the soy yogurt is attached in Appendix 3.

Formulation of Smoothie Blends

Soy smoothie was derived from blending soy yogurt and a fruit juice blend (saskatoon berry juice and sour cherry juice and black currant juice) then adding stabilizers for a good beverage suspension and vitamins and minerals to meet Health Canada requirements (Appendix 6).

Five different gums were tested, and a multiple gum blend that performed best under the pasteurization process complemented the acidity of the final smoothie and displayed strong emulsion properties within the beverage ingredients was chosen. Dairyblend 850-CS (consist of pectin, maltodextrin, guar gum, xanthan gum) was first hydrated and mixed with water then added to the soy yogurt and juice blends.

Vitamin and mineral premix were added next and mixed well using a hand whisk. White grape juice concentrate was added and the final brix adjustment was made to target a brix value of 14^{o} Brix.

To ensure food safety and good shelf-life stability, the final smoothie was pasteurized at 82-85^{o}C for 5minutes. After pasteurization, the product was homogenization in the blender at speed 4 for 3 minutes to form a smooth texture. The finished product (smoothie) was packaged in glass jars and stored in fridge.

The final soy-Saskatoon smoothie formula shown in Table 2 was chosen based on the sensory attributes chosen by panelists and described as well- balanced fruity flavour, smooth mouth feel. The smoothie also contained a good nutritional composition and displayed a clean ingredient listing. **Table 2: Formulation of soy-Saskatoon smoothie**

Ingredient	%
Soy yogurt	56.07
Saskatoon berry juice	19.75
Water	14.49
Grape juice concentrate	3.7
Sour cherry juice	3.29
Vitamin minerals premix	1.05
Dairyblend 850	0.72
Black currant juice	0.66
Flavour	0.27
Total	100

The equipment used for the development of soy smoothie is listed in Table 3.

Table 3: Equipment list, model and processing requirement

Equipment Name	Model at FDC	Process Required for
Kason Sifter	Model # K24 3 SS	Sieving soymilk
Colloid Mill	Model #CH4310 RHEINFELDON	Homogenizing
Rational Oven	Whitefficiency	Incubation of culture for yogurt making
Nicholson Proofer	Model # LR 50984	Incubation of culture for yogurt making
Blender	Oster	Homogenizing

Evaluation of prototype soy smoothie

3.1.4 *Analytical test on soy smoothie*

As shown in the Table 4, the prototype samples prepared on various dates have a brix content in the range of 14.8-17.5^{0}Brix, and the % malic acid is between 0.3953 and 0.5896, but the overall perception of sweetness and acids depend on the ratio of brix and acid. It was identified that the higher the value of brix to acid ratio, the sweeter the taste was perceived by panellists. In contrast, the lower the brix to acid ratio indicated a higher tartness of taste of the product. Therefore, sample 3 had the sweetest perception but lacked the acidity to balance off the sweetness, while sample 5 tasted the most acidic but lacked the yummy taste from a sweet perception. Not a lot differences on sensory profile were noticed for sample 1, 2, 4 and 6, therefore, it is recommended that the optimal ratio of brix and acid was between 30 and 32.

Table 4: Analytical tests of smoothie sweetened by grape juice concentrate

Smoothie Sample	pH	Brix	Total acidity (% malic acid)	Brix/acid ratio
1	4.46	16.5	0.536	30.8
2	4.49	16.3	0.5159	31.6
3	4.48	14.8	0.3953	37.44
4	4.35	15.5	0.4958	31.26
5	4.46	15.2	0.5896	25.78
6	4.34	17.5	0.536	32.65

3.1.5 *Sensory attributes*

As a precaution to consider prevent allergic reactions caused from consuming soy foods, questionnaires were distributed among consumers, and ten panelists from FDC, who consume soya foods, were qualified and chosen for a consumer acceptability test. The panelists chosen covered age group from 25-65 years old, both genders, and a wide demographic from all over the world and most of them were familiar with the procedure of sensory testing. Five attributes including sweetness, acidity, flavour balance, creaminess and overall acceptability were rated on a four point scale. Figure 2 displays the average point for each attribute. Panelists agreed that the soy-saskatoon smoothie had a moderately sweet, slightly acidic, moderately balanced flavour with moderately creamy texture and was moderately acceptable.

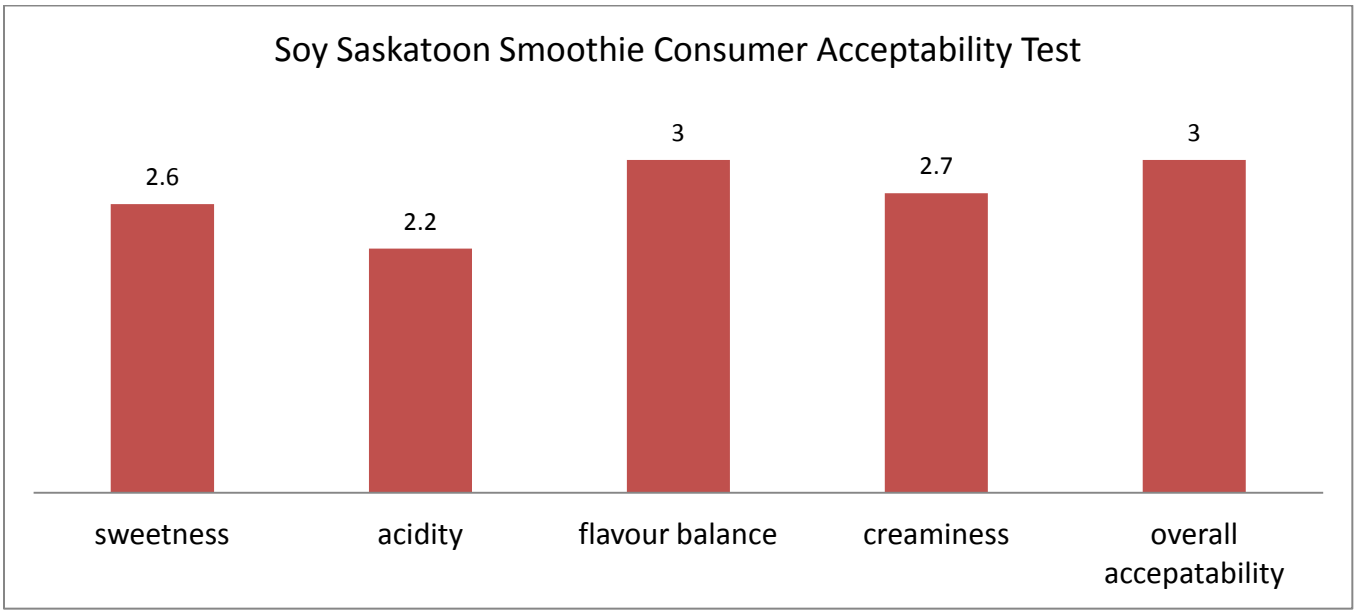

Figure 2: Consumer Acceptability Test of soy-saskatoon smoothie

3.1.6 *Nutritional Profile*

Nutrition Facts
Valeur nutritive
Serving Size 1 cup (250ml)
Portion 1 tasse (250ml)

Amount / Teneur	% Daily Value / % valeur quotidienne
Calories / Calories 170	
Fat / Lipides 1.5 g	**2** %
Saturated / saturés 0.5 g + Trans / trans 0 g	**3** %
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 30 mg	**1** %
Carbohydrate / Glucides 33 g	**11** %
Fibre / Fibres 3 g	**12** %
Sugars / Sucres 21 g	
Protein / Protéines 8 g	
Vitamin A / Vitamine A	0 %
Vitamin C / Vitamine C	0 %
Calcium / Calcium	40 %
Iron / Fer	20 %

The final prototype was sent to an external accredited laboratory for its nutritional analysis. The Genesis® R & D SQL nutrient database was used to generate the final Canadian nutritional facts tables (NFTs) for the smoothie based on the external laboratory results. The nutritional composition of the smoothie is shown by the NFTs (Figure 3). According to Health Canada regulations, the following nutrient content claims can be made for the soy Saskatoon smoothie:

- High in iron,
- Very high in calcium,
- Source of fiber,
- Low in fat,
- Low in saturated fat

Ingredients Listing: soymilk, Saskatoon berry juice, water, grape juice concentrate, sour cherry juice, inulin, vitamins and minerals (Vitamin A, Vitamin D2, Vitamin B2, calcium lactate, zinc gluconate, maltodextrin), Dairyblend(pectin, maltodextrin, guar gum, xanthan gum), black currant juice, natural flavour, culture

Figure 3: Nutrition facts table of soy-saskatoon smoothie

3.1.7 *Shelf life stability*

Initial testing of the final smoothie stored **at room temperature** was not considered acceptable after one week, due to discoloration, oxidation and suspension. Samples stored **at refrigeration temperature** continued to be acceptable hence the preliminary shelf life study was conducted at refrigeration temperature. Microbiological and physical tests were conducted as well as sensory tests by three panelists to monitor food safety and quality. As shown in Table 5, the microbial counts indicated that the product was safety for consumption after one month and possible longer.

Table 5: Shelf-life micro test results of soy-saskatoon smoothie at refrigeration

Shelf-life Day	TPC	E coli	Coliform	Yeast	Mold
Day 0	<10	<10	<10	<10	<10
Week2	35	<10	<10	<10	<10
Week 4	108	<10	<10	<10	<10

Physical results: After one month storage, separation of phases was observed and shaking the bottle to provide a consistent product was necessary before drinking (Table 6.) Panelists considered the smoothie to contain a pleasant, fruity and sweet aroma; creamy and smooth mouth feel, but this flavor changed over time, as both sweetness and acids profiles diminished over time and very slightly bitter taste was noticed by panelists at week 4. Further testing was not conducted.

Table 6: Shelf-life analytical and sensory results for soy-saskatoon smoothie at refrigeration

Shelf-life day	pH	Brix	Acidity	Brix/Acid Ratio	Sensory
Day 0	4.46	16.5	0.536	30.78	Fruity aroma, balanced sweetness and acids, creamy texture
Week 2	4.38	16.3	0.603	27.03	Very fruity flavour, creamy texture, whey separate
Week 4	4.39	15.7	0.575	27.30	Nice balanced sweetness and acids, very slightly bitterness, nice aroma

4.0 Conclusions

Soy Saskatoon berry smoothie is a drinkable soy yogurt with fruits blend, produced from defatted soymilk and fresh Saskatoon berry juice and other Manitoba berry juices. The final prototype made with grape juice concentrate is high in iron, very high in calcium; it is a source of fiber and low in fat and saturated fat. It has a pleasant soy beverage with less beanie soy characteristic flavor than traditional soy beverage, and may be well received by the general public. The blend of Saskatoon berry, sour cherry and black currant juices makes this drink even more flavorful and appealing in colour. Unlike traditional soy product, in which gritty earthy mouth feel are always noticed by consumers, a smooth and creamy mouth feel was obtained in this soy Saskatoon smoothie prepared with a unique formulation and process.

5.0 Opportunities and challenges

The development of soy-Saskatoon berry smoothie demonstrates that food grade Manitoba-grown soybeans can be processed into a value-added high-end premium beverage. It allows the opportunity for the soybean oil manufacturer to find ways of adding value to defatted soy meal/cake so the whole soybean is utilized. Alternatively, the smoothie can be produced from whole soy milk and the opportunity for further research on identifying additional Manitoba soybean varieties suitable for food processing can be explored.

The soy yogurt developed as an ingredient in this project can be optimized and could be a great carrier for Probiotic. Additional value-added new products can be further developed such as yogurt based soy dessert, dips, soy cream cheese. Although the yogurt was not able to retain all the live cultures as pasteurization steps were applied, fermentation is still considered as a very important process to reduce the beanie flavor, reduce oligosaccharides, and modify the texture of soy. Further development to produce better tasting soy flavoured products incorporating a fermentation step can be explored with other future soy products.

To enhance the fruity flavour profile of the smoothie, the blending of Saskatoon berry juice, sour cherry juice and black currant juice was considered more flavour-full than using single juices alone. This is an opportunity for Manitoba Small Fruit Growers to add value to their Pre-pick markets and consider freezing berries for juice processing. The technology to manufacture juice is available at FDC and can be easily transferred to allow juice blends to be manufactured and made available for smoothie beverages.

The opportunity for FDC and MPGA to work with a Manitoba company such as NUEATS will assist this unique beverage to move another step towards commercialization by conducting a test market for consumer acceptance.

6.0 Reference

Global Industry Analysts, Inc. 2010. Global Smoothie Market to reach $9 billion by 2012, according to New Report by Retrieved from: http://www.prweb.com/releases/smoothies_market/frozen_mix_smoothie/prweb3808804.htm on Jan 2, 2013

Nessinger, T. B. 2011. Smoothie Operators. Prepared Foods. Oct 2011.

Nelson, A.I., Steinberg, M.P., and Wei, L.S. 1976. Illinois process for separation of soymilk. Journal of Food Science. 41; 57-61.

Nelson, A.I., Wei, L.S., and Steinberg, M.P. 1971. Food products from whole soybeans. Soybean Digest 31 (3):32.
Nessinger, T. B. 2011. Smoothie Operators. Prepared Foods. Oct 2011.

Pinthong, R.,Macrae, R. & Rothwell, J. 1980.The development of soya-based yogurt. Journal of Food Technology, 15, 647.

U.S. Food and Drug Administration. Final Rule: Food Labeling: Health Claims; Soy Protein and Coronary Heart Disease [Web site]. October 26, 1999. Available at: http://www.fda.gov/Food/LabelingNutrition/LabelClaims/HealthClaimsMeetingSignificantScientificAgreementSSA

Weihrauch, an JL, Gardner J.M; 1978.Sterol content of foods of plant origin. Journal of American Diet Association, 73:39-47.

Wilkens, W.F, Mattick, L.R., and Hand, D.B. 1967. Effect of processing method on oxidative off-flavor of soybean milk. Food Technol. 21:86.

Wilkens, W.F. and Lin, L.M. 1970. Gas chromatographic and mass spectral analyses of soybean milk volatiles. Journal of Agric.Food Chem. 18:333.

7.0 Appendices

Appendix 1: Commercial samples analysis

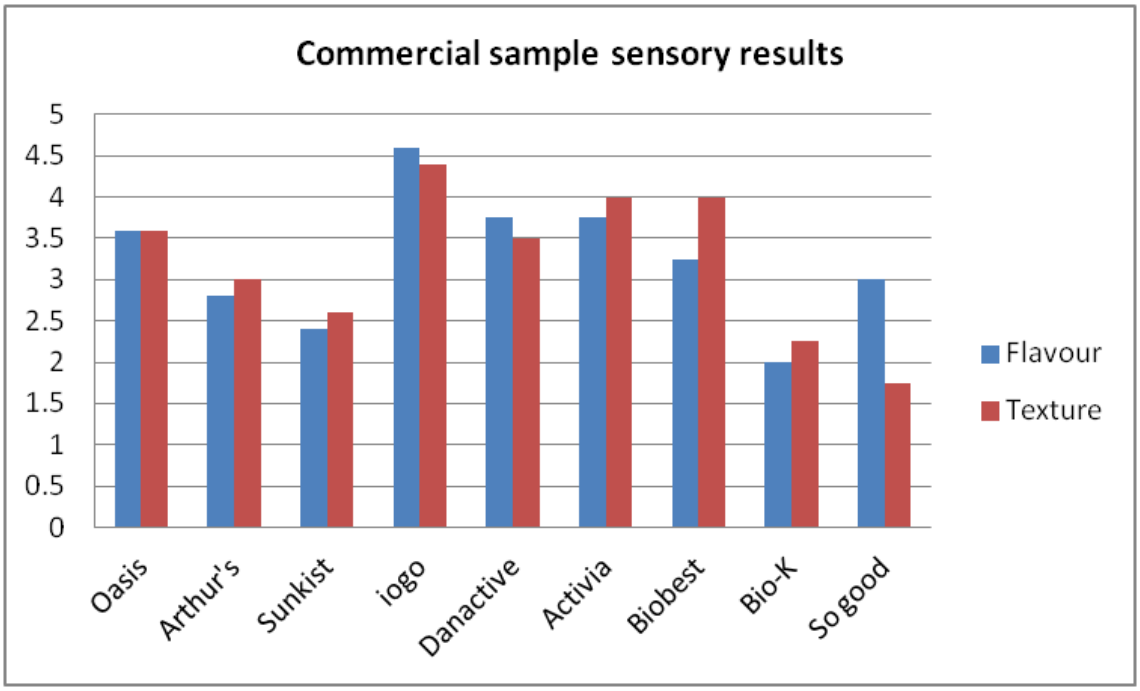

Figure 4: The sensory results for commercial samples

A group of 5 consumers were chosen to evaluate the flavour and texture on a 5-point scale (1: like the least, 5: like the best). Appendix 1 details the results of the sensory evaluation. The results showed that panellists preferred the smoothies containing flavoured yogurt with or without fruit over a soy beverage. Panellists preferred a balance of sweetness and acidity combined with a creamy texture over a beanie aftertaste of soy beverages. Analytical tests were also conducted on the preferred smoothie brands to assess their qualitative characteristics. This included the measurements of the brix, ph, acidity and the ratio of brix/acidity. The overall result was that panellists preferred the ÏOGO brand smoothie over all other brands.

Watery mouth feel and unpleasant beanie aftertastes in the So Good brand were noticed by panellists. The flavour of Bio-K was too acidic to be accepted. In fruit based products, Oasis brand was considered the best in tasting experience due to the creamy texture and cleaner taste. The dairy-based beverages had a higher preference than other products because of the balanced sweetness and acidity and creamy texture. Soy-based smoothies were not found in the local market, and utilization of Saskatoon berry in the smoothie was not common either. However, relatively similar commercial samples were purchased from local store, including soy beverage, soy yogurt (Bio-K), fruit based smoothie (Oasis, Arthur's, Sunkist), and dairy based yogurt drink (Danactive, Activia, and Biobest)

Analytical tests were also done on the chosen products to provide date for the development of the soy berry smoothie. Considering the nature of soy smoothie and panellists' preference, the texture of Oasis is being chosen as the target. Its viscosity was measured at 436 cp with Viscometer spindle 4 at 100 rpm. In the contrast, yogurt drinks Activia and ÏOGO had better flavour profile. The brix, ph, acidity and the ratio of brix/acidity were measured as shown in the table below.

Table 7: Analytical tests on commercial samples

Sample	ph	Brix	Acidity	Brix/ acid ratio	Sensory
Oasis	4.19	12.2	0.352	34.66	Too acidic, not sweet enough
Activia	4.52	17.5	0.4736	36.95	Good balance of sweetness and acidity
ÏOGO	4.42	13.8	0.4288	32.18	Good flavour balance

Appendix 2: Evaluation of soymilk

Soymilk extracted from defatted soy cake was compared to commercial soymilk brands *Silk* and *So Good* for protein, calcium and fat content. The results are shown in Table 8. The protein content was similar in the defatted soy milk compared to the commercial brands *Silk* and So *Good.* However, the calcium content of the defatted soy milk was significantly less, as the commercial brands were fortified with calcium.

Table 8: Comparison of soymilk derived from defatted soy cake to commercial soymilk

	Silk[1] Plain Soymilk	*So Good* [2] Original	RCFFN Defatted Soymilk [3]
Protein (%)	2.88	2.8	3.30
Fat (g/100g)	1.65	1.6	1
Moisture (g/100g)	91.53	----	92.6
Energy (Cal/100g)	41	44	33
Carbohydrates (g/100g)	3.29	4.8	2.6
Calcium (mg/100g)	123	123.2	27

* [1] USDA Nutrient Database from http://ndb.nal.usda.gov/ndb/foods/show/4904?fg=&man=&lfacet=&format=&count=&max=25&offset=&sort=&qlookup=soymilk+

[2] So Good Beverage from http://www.sogoodbeverage.com/beverages_original.cfm

[3] External laboratory analysis

Soymilk Sensory Properties Comparison

Both *Silk* and *So Good* soymilk extracted from whole soybeans had a smooth and creamy mouth feel with a moderate level in beanie flavor were noticed by panelists. In comparison, soymilk obtained from defatted soy cake had a moderate level beanie flavor and only a slight creamy mouth feel, probably due to the lower fat content. It was also confirmed by our study on extracting soymilk from whole soybean by use of traditional Oriental method, and the whole soymilk had a stronger beanie flavor than defatted soymilk, which is probably due to the oxidation of lipids via lipoxygenase during process.

Analytical comparison between full fat and defatted soymilk

Table 9, displays the results for the pH value and brix value of whole soy milk and defatted say milk. Both samples have similar ph and brix values. However soymilk extracted from whole soybeans resulted in a lower total solids (mainly proteins) recovery (5.59 % compared to 9.01%), which is partly resulting from higher water to bean ratio.

Table 9: Comparison of full fat and defatted soymilk

Sample	pH	brix	total solids
Full fat	6.72	6.4	5.59
Defatted	6.34	6.4	9.01

Appendix 3: Evaluation of soy yogurt

Yogurt is perceived by consumers as an acidic and tart with creamy and smooth texture. The quality of soy yogurt is affected by its formulation ingredients and processing methods. As discussed in literature review, good yogurt has the lactic acid content not less than 0.85%.

Soymilk from whole soybeans and defatted soymilk were formulated the same and incubated at the same temperature and time. As shown in Table 10, full fat soy yogurt had a lower pH value which indicated that full fat soymilk fermented faster than defatted soymilk, it had a slightly higher content of lactic acid. However, the overall lactic acid formed in the soy yogurt was still below the regular yogurt, which was a common problem in making non-dairy yogurt. Other choices are available but considering that the soy yogurt was only an intermediate product in the development of soy smoothie; therefore, no further optimization was carried out.

Table 10: Comparison of full fat to defatted soy yogurt

	pH	lactic acid %
Full fat	4.18	0.612
Defatted	4.57	0.441

Appendix 4: Traditional Oriental method for soymilk extraction from whole soybeans

Whole soybeans were soaked in water (ratio 1:4) overnight, and drained and rinsed twice with water. And then soybeans were grinded with water (1:1) at speed of 3500rpm for 5minutes. Reconstitution with water (5 times the weight of soybeans) was followed and mixed with handheld Blixer at speed of 8 for 5 to 10 minutes and then cooked at 80-90◦C for 20 minutes. After cooking, the mixture was filtered through Kason sifter by using mess size of 40/80, and soymilk and soycake residue were collected separately. In order to prolong the shelf life of soymilk, soymilk was pasteurized at 85◦C for 6 minutes and then stored in freezer.

Appendix 5: Sensory ballot for soy-saskatoon smoothie

PJ# 3658 Soy-saskatoon Smoothie Name:_____ Date:_____ Date:_____

Sweetness	**Acidity**	**Flavour balance**	**Creaminess**	**Overall acceptability**
1. none	1. none	1. not balanced	1. not creamy	1. unacceptable
2. slightly sweet	2. slightly acidic	2. slightly balanced	3. slightly creamy	2. slightly acceptable
3.moderately sweet	3.moderately acidic	3. moderately balanced	3. moderately creamy	3. moderately acceptable
4. extremely sweet	4. extremely acidic	4. extremely balanced	4. extremely creamy	4. extremely acceptable

Sample ID	Sweetness	Acidity	Flavour balance	Creaminess	Overall acceptability

Comments: _____

Appendix 6: Vitamins and Minerals requirement by Health Canada

As shown in the Table 11 and 12 below, items in Column 1 must meet the minimal requirement in Column 2 before they can be fortified. Other vitamins and minerals that can be fortified in plant-based beverage are listed in table below.

Table 11: Vitamin and minerals fortifications that must be present in plant-based beverage

Column 1	Column 2
Vitamin or Mineral	Amount per 100ml ready-to-serve
Vitamin A	40 RE
Vitamin D	0.85 µg
Vitamin B12	0.4 µg
Riboflavin	0.15 mg
Calcium	125mg
Zinc	0.4mg

Table 12: Vitamins and minerals that can be fortified in plant-based beverage

Column 1	Column 2
Vitamins or mineral	Amount per 100ml ready-to-serve
Vitamin B6	0.04 mg
Vitamin C	1.0 mg
Thiamine	0.04 mg
Niacin	0.85 NE
Folacin	5.0 µg
Pantothenic acid	0.35 mg
Phosphorus	100 mg
Potassium	150 mg
Magnesium	12 mg

Appendix 7: Ingredients suppliers' information

Ingredient	Supplier contact info	Price
Soy beans (HS006RYS24)	RJP Seed Ltd. Rob Park Tel: 204-745-0088	20/bushel
Soymilk powder	Benesoy	_____
Inulin LV 110 Powder	Tic Gums	15.77/kg
Tic Gum 850-CS	Tic Gums	
Vitamin mineral premix	Calico Food Ingredients, Keith Mitchell. Tel: 613-634-6836 keith@calicofoods.com	18.1/kg
White Grape juice concentrate	Fruit Smart Inc. Box 177 Prosser, Washington U.S.A. 99350	92.5/5 gal pail
Saskatoon berry	Eastern Plains Saskatoons Inc Mailing Address: Box 334 Warren, Manitoba Canada R0C 3E0	1/lb
Sour cherry	Prairie Adventure Farm Edith and Wayne Smith Tel: 204-745-2678	3/lb
Black currant	Prairie Adventure Farm Edith and Wayne Smith Tel: 204-745-2678	1/lb
Flavour	Metarom Neotech, Technical representative Emilie Le Bihan Ph: 604-563-9712 Fax: 604-291-0061	25/kg
Culture (Yo-Mix™Vegtal 7)	DuPont Canada - Nutrition & Health Andrea Campos Inside Sales Account Representative Ph: (416) 646-1905 Cell: (416) 896-4487 @: andrea.campos-1@dupont.com	$ 76.33 per bottle (375 DCU)