Development of Two Frozen, Microwaveable Pulse and Vegetable Side Dishes

Food Development Centre Project #3434

Final Report

Submitted to:

Manitoba Pulse Growers Association

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EXECUTIVE SUMMARY

Manitoba produces a variety of pulse types and soybeans but dry edible beans and genetically modified (GM) soybeans comprise the majority of the acres. While these crops are highly nutritious and provide a variety of health benefits, long cooking times and flatulence issues are two key reasons for traditionally low consumption of these crops in North America. Additionally, few convenience products containing these crops are available to consumers and the existing retail products often contain insignificant quantities of the crops.

Flatulence in pulses and soybeans is primarily due to the bacterial degradation of oligosaccharides (long chain sugars - stachyose and raffinose) and starch which is not fully broken down because of the enzyme (alpha-amylase) inhibitor.

To address the lack of convenience products for these crops and the flatulence issue, the Manitoba Pulse Growers Association (MPGA) funded research by the Food Development Centre (FDC) to develop two frozen microwavable side dish prototypes containing beans/soybeans and vegetables as the major ingredients. The first objective of the project was to determine optimal processing procedures to apply to Manitoba pulses/soybeans for use in a frozen microwavable side dish application. Ideally the process would reduce flatulence of the processed products without compromising quality. The second objective was to develop two frozen, microwavable, gluten-free side dish prototypes (one containing soybeans) using a blend of processed pulses and vegetables that capitalize on the health benefits of the crops.

Edible dry beans and soybeans (non GM) were selected for the project because they are key Manitoba crops, the majority of the crop is exported, and they are known to be highly flatulent compared to other pulses. Based on 2007-2011 bean and soybean variety acres reported by Manitoba Agricultural Services Corporation (MASC), the top two soybean varieties (non GM) and the top two varieties from each of the top five bean classes (navy, pinto, black, kidney, and cranberry) plus 3 random varieties (other bean classes) were selected for preliminary evaluation.

Preliminary trials examined the effect of soak and cook water to bean ratios, soaking time, and cooking method on bean quality (degree of wrinkling, splitting and colour leaching). Additionally, water uptake (% weight gain) and moisture content after soaking were calculated.

One variety from four bean classes was chosen for additional study: Eclipse (Black bean), Pink Panther (Light Red Kidney bean), Windbreaker (Pinto bean), Envoy (Navy bean), and OAC Erin (non GM soybean). As the research progressed, new crop (2012) beans were required; however, Envoy navy beans could not be obtained so research continued with the Cargo variety.

Based on the preliminary trials, the following process for IQF beans/soybeans was developed: 12h soak, rinse (2x), boil, rinse (2x), air dry, and freeze. Addition of a drying or a freezing step before boiling (using regular soak water or 5% sugar solution) proved unsuccessful for oligosaccharide reduction. The developed process was shown to effectively reduce oligosaccharides (0.120% stachyose and 0.19% raffinose) and alpha-amylase inhibitor activity (< level of detection) in Cargo beans.

To make the process more applicable to industry, the 12-hr soak and the second rinsing steps were removed. While alpha-amylase inhibitor activity was not detected in beans processed using the modified process, the modified process was less effective in reducing stachyose (0.274%) than the original process; however, compared to commercially-processed and consumer-processed beans, a greater reduction of oligosaccharides was observed. The recommended process for the IQF beans/soybeans is: 2h pre-soak, drain & rinse, short/hot soak (boil 3 min, 2h soak), drain & rinse, boil, drain & rinse, air dry, and freeze. This process was optimized for the other bean/soybean varieties (Eclipse, Pink Panther, Windbreaker, and OAC Erin). The following cook times were established for each bean (black - 14 min, pinto - 18 min, navy - 17.5 min, and soy - 24 min).

Instrumental texture and colour analyses indicated the five IQF test beans (processed without firming and colour retention processing aids) were generally comparable to IQF beans from a US manufacturer, although some differences specific to bean class were observed.

A process for IQF beans/soybeans with reduced flatulence was developed. No processing aids (firmness, colour retention) were used, resulting in a more “natural”, clean label product. The developed process can be adapted to current industry practices and thus has the potential to increase utilization of beans/soybeans as IQF products and ultimately increase demand for these crops.

IQF Manitoba beans (black, navy, and pinto) and non GM soybeans that are processed to reduce flatulence can be combined with IQF vegetables and seasonings to produce microwavable side dishes that are tasty, gluten-free, non-GM, nutritious, non-allergenic (without soybeans) and have wide market appeal. It is possible to incorporate a high percentage of beans/soybeans (approximately 50%) into the side dishes. High likeness scores for the prototypes suggest that seasoned side dishes containing a 1:1 ratio of beans/soybeans to vegetables could be successful in today's marketplace as premium products providing superior nutrition and health benefits.

Although IQF dry soybeans are not commercially available, they performed very well in this application suggesting a new opportunity exists in North America for value-added IQF soybeans.

Thus by identifying processing methods to reduce flatulence and by developing value-added applications for Manitoba beans and soybeans, this research has demonstrated the potential to position these crops more favourably in the eyes of the North American food industry and consumers and thus facilitate their greater utilization.

1.0 INTRODUCTION

Pulses (dried bean, pea, chickpea and lentil seeds) and soybeans are nutritious, health promoting, gluten free, low glycemic index (GI), environmentally friendly foods. While pulses are low in fat and not genetically modified (GM), soybeans have a moderate fat content and both GM and non GM varieties are used by North American food processors.

Although Manitoba produces both pulses and soybeans, dry edible beans and GM soybeans comprise the majority of the acres. In 2013, 93,988 bean acres and 1,056,652 soybean acres were grown. Pinto, navy, black, kidney, and cranberry are the major bean classes grown in Manitoba; in 2013, 36,404 pinto acres, 28,913 navy acres, black 9,535 acres, and kidney/cranberry combined acres were grown (MPGA, 2013).

Canada's edible bean crop is primarily exported to Angola, US, UK, and Mexico (MPGA, 2013). In the US, beans are primarily processed into canned beans (navy beans), re-fried beans (pinto), Hispanic products (black), and chili (kidney). The main market for GM soybeans is US oil crushers while non GM soybeans are primarily sold to international markets for processing into soy products such as tofu and soy sauce (Der, 2013). Canadian beans and soybeans sold to food manufacturers are not segregated by geographic region or variety although food processors can specifically contract Manitoba beans or a specific variety.

Edible dry beans and soybeans are known to be highly flatulent while consumption of peas, lentils and chickpeas results in less gas production (Veenstra, et al., 2010). Flatulence or intestinal gas production, results when long chain sugars (oligosaccharides) and starch from pulses and soybeans are broken down by bacteria present in the small intestine. Stachyose is the main oligosaccharide in pulses and soybeans but raffinose and verbascose are also present at low levels with only trace amounts found in chickpeas and navy beans (Rackis, 1981). Oligosaccharide digestion requires the enzyme alpha-galactosidase which is lacking in humans, thus, breakdown results from bacterial activity in the small intestine. While soybeans contain little starch, pulses contain 30 to 50% starch which is partially broken down by the naturally occurring alpha-amylase enzyme before reaching the small intestine. Bacterial degradation of digested starch may also contribute to flatulence production (Pulse Canada, 2012).

Soaking and cooking; frequent water changes during soaking and cooking; and rinsing of soaked and cooked pulses/ soybeans are known to reduce flatulence. Other processing treatments associated with flatulence reduction include enzyme application, fermentation with lactic acid bacteria, and germination in the presence of micro-organisms (Rackis, 1981). Most research has focused on role of oligosaccharides in flatulence production.

The occurrence of flatulence, lengthy cooking times, and consumer unfamiliarity with how to prepare pulses and soybeans has caused domestic consumption to remain low (Suarez, et al., 1999). Thus, greater availability of ready-to-eat products containing pulses and soybeans which have been processed to reduce flatulence is needed to increase their consumption.

North American consumers are seeking convenient, tasty, nutrient dense (especially high fibre and protein) foods that also provide health-related benefits such as satiety; low GI; antioxidant content; and low levels of sodium, saturated/trans fat and sugar. In addition, a growing number of consumers are seeking plant-based proteins and products without allergens/gluten and GM ingredients (Lea, Crawford and Worsley, 2006). However, only a small number of retail products offer pulses and soybeans in a convenient format and some products such as canned beans are high in sodium while others like frozen side dishes contain only a small proportion of pulses/soybeans (Veenstra, et al., 2010).

Pairing beans and soybeans with familiar healthy ingredients such as vegetables in a frozen microwavable side dish application would satisfy numerous consumer demands, facilitate increased consumption of pulses and soybeans, and expose consumers to the benefits of pulses and soybeans. A few frozen side dishes containing pulses (typically black beans, navy beans, and chickpeas) and shelled edamame (green soybeans harvested prior to maturity) are commercially available but pulses and edamame are minor components (Abu-Ghannam and Gowen, 2006).

Frozen side dishes are available either as individually quick frozen (IQF) products that enable end users to prepare the desired amount or as pre-portioned units containing sauce and seasonings. IQF side dishes are more prevalent in retail and food service markets and manufacturers of IQF side dishes typically purchase IQF ingredients to custom blend and season (Ajmera, 1999).

Edamame, chickpeas, lentils, and a variety of beans are available as IQF ingredients. IQF soybeans and peas are not currently produced because these crops are further processed into higher value products such as protein isolates, fibre, soy milk, and tofu (Der, 2013). IQF applications require pulses with high visual integrity. Beans are prone to splitting and cracking during processing thus premium quality beans are required. Processing aids such as calcium chloride (firming agent) and ferrous gluconate (colour retention) are typically used in bean processing to enhance quality of the final product (Bush, Bettle and Rutziski, 2002).

The basic process to prepare IQF pulses entails hydration, cooking, freezing, and packaging; lentils do not require hydration. IQF processors use either boiling or steaming methods to cook pulses. Some processors use continuous blanching systems to hydrate and cook pulses while others use traditional batch soaking to hydrate the beans prior to cooking. Most manufacturers of IQF pulses are more concerned with quality than flatulence levels (Ajmera, 1999).

Processing times and quality of the final product are influenced by age of the pulses/soybeans, growing conditions, geographic region, class/variety, and size. Older pulses require longer soaking/cooking times and they result in more cracking and splitting.

This report provides the results of research conducted by the Food Development Centre (FDC) to develop two frozen microwavable side dish prototypes containing beans/soybeans and vegetables as the major ingredients. The first objective of the project was to determine optimal processing procedures to apply to Manitoba pulses/soybeans for use in a frozen microwavable side dish application. Ideally the process would reduce flatulence of the processed products without compromising quality. The second objective was to develop two frozen, microwavable, gluten-free side dish prototypes (one containing soybeans) using a blend of processed pulses and vegetables that capitalize on the health benefits of the crops. Funding for this research was provided by the Manitoba Pulse Growers Association (MPGA).

2.0 METHODS

2.1 Analytical Methods

2.1.1 Moisture Content

Samples of navy, black, pinto, red kidney and soy beans were measured for moisture content (%) by two methods. One method was measured on 3 to 6 grams of beans using the rapid moisture analyzer model IR-30 with infrared technology for drying at 130°C. The dry oven method was also used with 3 to 6 grams of beans using the Cole Parmer Company conventional oven for 24 hours at 70°C. All samples were measured on an “as-is” basis.

2.1.2 Texture

Bean samples processed commercially by Hanover Foods (US) and in FDC's food laboratory were analyzed for texture by using the TA.XT2*i* Texture Analyzer (Texture Technologies Corp.) and AACC International Method 56-36.01 Firmness of Cooked Pulses.

2.1.3 Brix

Brix (°) was analyzed after each major processing and rinsing step using the Abbe Mark II Plus Refractometer (Model 13104940, Reichert Analytical Instruments) and Brix method outlined in AOAC International, Volumes I and II.

2.1.4 Colour

Bean samples processed commercially by Hanover Foods (US) and in FDC's food laboratory were analyzed for colour by using Konica Minolta Chroma Meter CR-400/410, measured on a L*a*b* scale.

2.1.5 Oligosaccharide Profiling

Five samples of 100 grams of navy beans were sent to an external laboratory (Medallion Laboratories) to be analyzed for oligosaccharide content by method AOAC 977.20. All samples were measured on an "as-is" basis.

2.1.6 Alpha-amylase Inhibitor Activity

Three samples of 100 g of navy beans processed commercially and FDC's food laboratory processed were analyzed by an external laboratory for alpha-amylase inhibitor activity by method AOAC 2002.01. All samples were measured on an "as-is" basis.

2.2 Sensory Evaluation Methods

2.2.1 Preference Testing

An untrained panel of 17 FDC staff evaluated two pulse vegetable side dishes with four different seasonings. The panel selected their favorite seasoning for each side dish and those two seasonings were selected for likeness testing. The ballots used for sensory analysis are shown in Appendix B.

2.2.2 Likeness Testing

The two seasonings selected through preference testing were further evaluated for likeness. An untrained panel of 14 FDC staff evaluated the dishes for overall appearance, aroma, texture, flavour and quality. The ballots used for additional sensory testing are shown in Appendix C.

2.3 Nutritional Information

Both final prototype side dishes were sent for full nutritional analysis to an external laboratory. Canadian Nutrition Facts Tables (NFT) was generated for each side dish using ESHA Research Genesis R&D SQL. All eligible nutrient content claims are based on a reference amount of 100 g according to the Guide to Food Labelling and Advertising under the Canadian Food Inspection Agency (CFIA).

4.0 RESULTS AND DICUSSION – DEVELOPMENT OF IQF BEANS

4.1 Preliminary Process Trials

Various pulse types (beans, peas, chickpeas and lentils) were considered for this research. Beans were chosen as they are the major pulse crop grown in Manitoba and the variety of sizes and colours would lend visual appeal to the side dishes. As Manitoba soybean acres are double the bean acres, soybeans were also selected for use in one side dish. Although non GM soybeans only comprise a small percentage of the soybean acres, they were deemed more appropriate for use in this application.

Based on 2007-2011 bean and soybean variety acres reported by Manitoba Agricultural Services Corporation (MASC), the top two soybean varieties (non GM) and the top two varieties from each of the top five bean classes (navy, pinto, black, kidney, and cranberry) plus 3 random varieties (other bean classes) were selected for preliminary evaluation.

In the initial stages, screening of numerous bean classes and varieties mentioned above (listed in Table 4.1) was performed. The varieties chosen for preliminary assessment were based on the % acreage in 2007-2011 report from Manitoba Agricultural Services Corporation.

Table 4.1 Bean and soybean varieties (2011 crop year) used for screening varieties

Bean Classes	Bean Varieties	Soybean Varieties
Pinto	Maverick	Prudence (from Roy OAC)
	Windbreaker	Prudence (from SunOpta)
	Unknown (Mixed)	Erin (from SunOpta)
Black	Eclipse	
	UI 911	
	Unknown (Mixed)	
Navy	Envoy	
	T99 03	
	Unknown (Mixed)	
Red Kidney	Pink Panther	
	Foxfire	
Small Red	AC Earlired	
Other (Brown)	Floyd	

In the assessment, beans and soybeans were soaked (4, 12 and 18 h) and then boiled or steamed (for 10, 15 and 20 min). The degree of wrinkling, splitting and colour leaching into the soak/cook water was assessed. Appearance and texture of the cooked bean/soybean samples was rated from 1 to 5, where 1 indicated poor and 5 indicated excellent visual characteristics (based on the amount of splits, loose hulls, uneven colour, un-even hydration). Additionally, water uptake (% weight gain) and moisture content after soaking were calculated. The soaked bean moisture content of ~55% indicated full hydration as indicated by Nelson and Hsu (1985).

The soaking time of 4 h proved too short to evenly hydrate the beans/soybeans and large differences in size and wrinkling were observed from bean to bean. Soaking for 12 and 18 h produced more uniformly hydrated beans/soybean with much less wrinkling. Therefore, data obtained from those two soaking times (shown in Appendix A) was used to screen some of the varieties out.

Additional screening was done after boiling/steaming trials, in which assessment of splitting, colour loss, cooked texture, and the texture retention with longer cooking was performed. Based on the results of the initial screening tests (not all reported here), one variety from four of the classes were selected. Good cooking quality/texture along with minimal wrinkling and splitting, and reasonable moisture uptake within soak time – which is more practical for the industry – were the basis of choosing the varieties. Decisions were also made based on the visual diversity of the prospective blends of the beans/soybean.

The chosen varieties were: Eclipse (Black bean class), Pink Panther (Light Red Kidney bean class), Windbreaker (Pinto bean class), Envoy (Navy bean class), and OAC Erin (non-GMO soybean). These varieties were sourced from the 2012 crop year. Obtaining the navy bean Envoy from MB growers was difficult, and therefore Cargo, another navy bean variety with high % acreage, was selected to continue the research. The proximate composition of the chosen field beans/soybean is given in Table 4.2 and the appearance is shown in Figure 4.1. It should be noted that the Cargo beans had a little more split/cracked cotyledons than the navy beans chosen initially. The 2012 crop year Pink Panther beans also had more cracked cotyledons, and generally more split beans were generated after soaking.

Table 4.2 Proximate composition of field beans (Pink Panther, Cargo, Windbreaker, and Eclipse) and soybean (OAC Erin)

Component	OAC Erin	Pink Panther	Cargo	Windbreaker	Eclipse
Moisture (%)	6.7*	10	8.5	9.9	10.2
Fat (%)	19.8**	1.1	1.4	1.2	1.3
Protein (%)	34.7***	23.0	21.3	25.0	21.0
Ash (%)	5.1	3.6	3.6	3.7	3.9
Energy (cal/100 g)	452	351	359	352	350
Carbohydrates (%)	33.7	62.3	65.2	60.2	63.6

*in un-ground sample; ** oil: as received; *** as is

Figure 4.1 Appearance of field beans: Pink Panther (A), Eclipse (B), Cargo (C), Windbreaker (D), and soybean: OAC Erin (E).

The black beans were used in the initial process development, as they leached more pigments during soaking and cooking. Therefore, ensuring acceptable appearance of the black beans after processing would to some degree ensure acceptable appearance of beans from the other classes.

In the process development, distilled water was used for soaking, cooking and rinsing the beans/soybean to eliminate the effect of mineral content inconsistencies from batch to batch. Also, water at room temperature (RT; 18-22°C) was used for soaking the beans, while ice water (~5-7°C) was used for rinsing the soaked or cooked beans. Trials with soaking water at elevated temperature (40°C) were also performed but the beans leached more pigment; the cooked texture was also firm, therefore a longer cooking time was required to achieve a similar texture to beans soaked at room temperature.

Initially, a long soaking time (12 or 18 h) was chosen in the process development as it allowed for full hydration of the beans/soybeans. The long soaking time can potentially increase harmful microbial proliferation. Therefore, a hot short soak (boiling in excess water for 3 min and stand for 2 h) was also tested and proved to fully hydrate the beans.

From the literature review and initial trials it was found that increasing the ratio of water to beans/soybean for soaking or boiling influences the amount of soluble components leaching into the water. Also, frequent change of soak water and rinsing between steps helps remove more solubles. Therefore, these steps were incorporated into the process and a 4:1 ratio of water to bean/soybean was used during soaking and a 3:1 ratio for boiling.

Cooking methods tested in this study included: boiling (simmer or rapid boil), steam blanching (stove top blancher), and steam cooking in Rationale oven at 160°C and 100% relative humidity. The temperature of 160°C for Rationale oven was chosen based on available literature which found that oligosaccharide content in bean flour decreased when extrusion at 163°C was performed. In the Rationale cooking method at 160°C, beans were placed in a pan, water was added to just cover the beans and the pan was covered with aluminum foil. The pan was then placed in the Rationale oven and exposed to steam for 8-12 min (depending on the bean variety/size). The beans/soybeans processed in the Rationale oven had acceptable appearance and good cooked texture (examples in Figure 4.2). The bean temperature while in the Rationale oven never exceeded 100°C within the treatment time used. Therefore this treatment was later abandoned due to the fact that the process resembled steam blanching, with the difference being that the beans were heated indirectly (pan was covered).

Figure 4.2 Soybean (OAC Erin) after processing in Rationale oven.

Trials were performed to optimize the boiling and steaming times for the four beans and soybean. Based on texture and appearance of the beans/soybeans as assessed by a 2-3 people panel, boiling was chosen over the steaming.

Based on the trials summarized above, the basic process to prepare IQF beans/soybean was developed. The basic process entailed a two-step soaking process, rinsing, water blanching, rinsing, air drying, and freezing (Figure 4.3). These steps/equipment options yielded beans/soybean with nice appearance and acceptable texture/flavour. The next section describes additional process steps that were investigated in order to reduce flatulence components during processing.

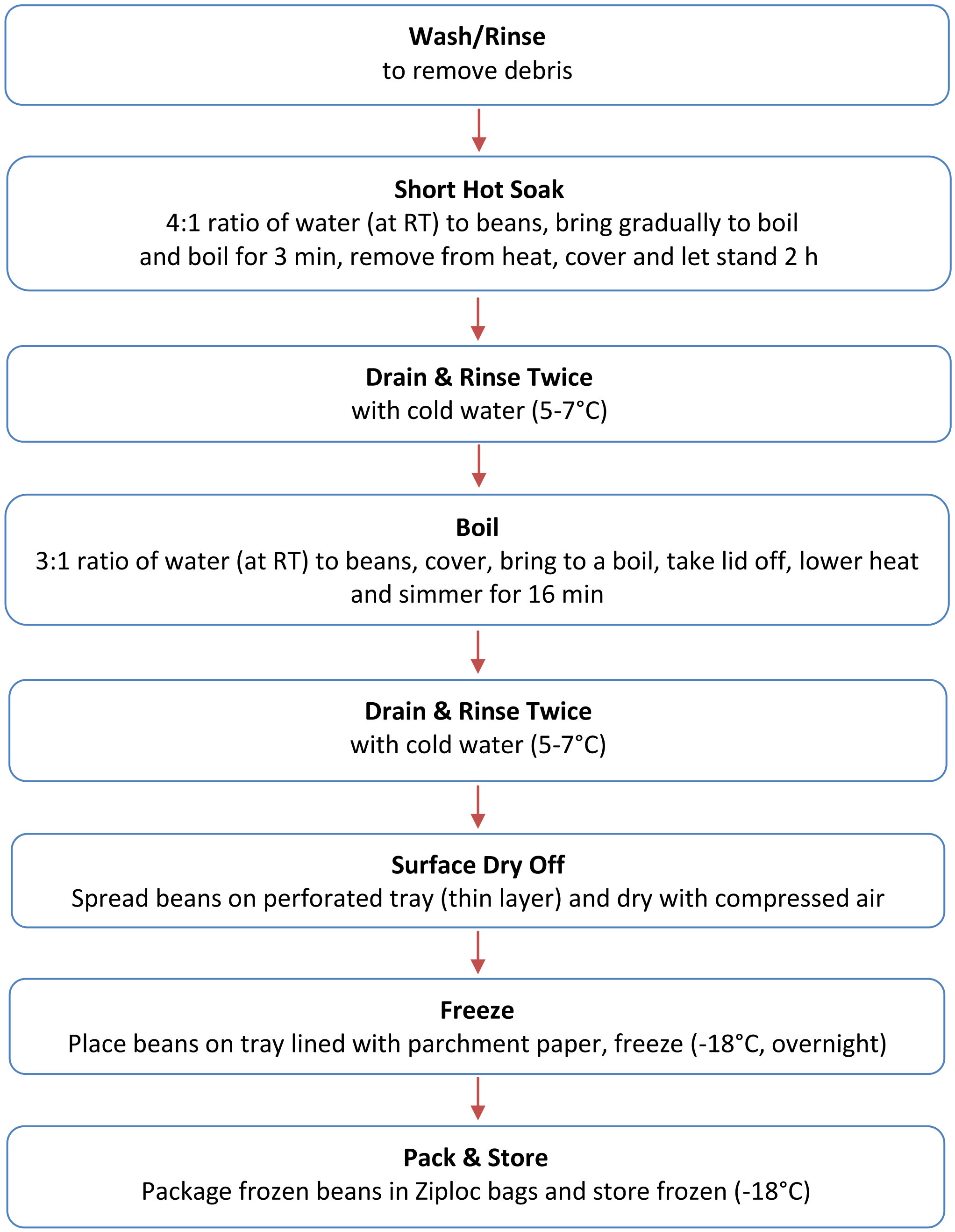

Figure 4.3 Initial process flow for bean/soybean IQF

4.2 Process for Flatulence Reduction

Cargo beans (navy bean class) were used during processing trials to reduce flatulence, as this class had the highest content of oligosaccharides (up to 1 % raffinose and up to 3.5% stachyose). Once the process was finalized for Cargo beans, the same process was applied to the other bean/soybean varieties (Eclipse, Pink Panther, Windbreaker, and OAC Erin), with the cooking/boiling step being optimized for each variety (details in the section 4.4).

Preliminary research determined that the main components responsible for flatulence in beans are oligosaccharides and the enzyme (alpha-amylase) inhibitor. Thus, additional processing steps were incorporated to potentially reduce the level of flatulence components while maintaining acceptable sensory characteristics (colour, texture, less "beany" flavour and minimal splitting) of the IQF beans. Samples from each treatment plus a control (beans boiled in excess water until acceptable texture was obtained; ~1 h boiling, without soaking or rinsing) were sent for oligosaccharide testing.

Trials were carried out to investigate if adding a drying or freezing step and 2 h soak step to the process (preceding the boiling step) would increase the leaching of oligosaccharides from the beans. Preliminary monitoring of oligosaccharide leaching was done by analyzing Brix after each rinsing step. Table 4.3 showcases the change in Brix after each rinse step for the processing scenarios mentioned below. The drying step was performed at 85°C. The beans were dried at that temperature to obtain the original MC (~9%). Substantial cracking and splitting of cotyledons occurred causing the visual appearance of the beans to dwindle (Figure 4.4). Subsequently, the drying step was eliminated from the process and the beans were not tested for oligosaccharide content.

Figure 4.4 Appearance of black beans after drying step.

The addition of a freezing step before boiling was studied in two scenarios, where beans were soaked first in regular water or in 5% sugar solution at 3:1 ratio of water/solution to beans. In order to realize the effect of sugar in solution, a longer soak time (12 h) was chosen for the trial. Also, addition of a conditioning soak (2 h, RT water, 4:1 water to bean ratio) at the beginning of the process was done based on the literature (Bush, et al., 2002). The conditioning step (pre-soak) helped to even the hydration level of beans with differing initial moisture contents. The following summarizes the process used in this trial:

- wash/rinse the beans
- pre-soak (2h, 4:1 ratio)
- drain/rinse
- soak in water or 5% sugar solution (12 h, 3:1 ratio)
- drain/rinse twice
- short hot soak (4:1 ratio, boil for 3 min, remove from heat, cover, let stand 2 h)
- drain/rinse twice *
- boil/shock (3:1 ratio, boil for 16 min)
- drain/rinse twice
- surface dry with compressed air
- freeze

*freezing step was added here to each sample (freezing at -18°C overnight followed by 2 h soak in water at 4:1 ratio)

Table 4.3 Change in Brix after each rinse step for Cargo (navy bean) in regular water and 5% sugar solution soak

Process Step	Brix (°)			
	Control (A)		w/ sugar (B)	
Drain after pre-soak	0.20		0.33	
Drain after overnight soak	0.67		5.37	
1st rinse after overnight soak	0.10		0.77	
2nd rinse after overnight soak	0		0.40	
Short Hot Soak	1.20		1.37	
1st rinse after short hot soak	0.07		0.20	
2nd rinse after short hot soak	0.07		0.13	
	Control Soak	Freeze Soak	Control Soak	Freeze Soak
1st rinse after freezing		0.03		0.13
2nd rinse after freezing		0.07		0.17
Thaw Water		0.33		0.33
Cooking Water	1.23	0.53	1.60	0.57
1st drain after cooking	0.20	0.17	0.43	0.20
2nd drain after cooking	0.20	0.17	0.33	0.17

Use of a sugar solution was investigated by Wilson, et al. (2006), who found a reduction of oligosaccharides following a soak in sugar water. The patent features reduced flatulence-associated oligosaccharides in a legume (by 94-99% RSO – raffinose-series oligosaccharides), by using a hydration step followed by a salination step (preferably 10 h in 5% NaCl solution at 20-50°C), followed in turn by de-salination step. The steps usually take place in sequence but may be preceded, followed, or interposed with one or more additional steps and/or components consistent with the goal of lessening or negating the unpleasant effects of flatulence associated oligosaccharides, while seeking to preserve organoleptic properties of the end product. The results of our study, however, did not show a significant reduction of oligosaccharides when sugar solution was used instead of water for soaking (results given in section 4.3). The Brix results showcased in Table 4.3 indicate that the freezing step as well as the 5% sugar solution also did not benefit the process.

4.3 Flatulence Analysis

4.3.1 Samples selected for Analysis

All treatments mentioned in section 4.2 were tested for Sugar Profiling (stachyose and raffinose). The purpose of the treatments was to conclude if different soaking treatments made a change in reduction of oligosaccharides. Two extra samples were tested: raw bean and no soak, straight boil, which acted as controls for the selected treatments. The no soak, straight boil sample was considered to mimic consumer processing methods. This involved no soaking or draining of the beans, which should have a higher percentage of oligosaccharides by the end cooked product. Referring to Table 4.4, no sugar-control soak treatment reduced stachyose and raffinose most effectively, reducing the sugars to 0.120% and 0.19%, respectively. Based on these results, this treatment was tested for alpha-amylase inhibitor activity. In order to have an applicable comparison, the no soak, straight boil treatment was chosen for the same reasons stated above.

4.3.2 Oligosaccharides

Table 4.4 Oligosaccharide (stachyose & raffinose) profiling results* on different treatments of navy beans

Treatment	Stachyose (%)	Raffinose (%)
Raw Bean	0.399	2.64
No Sugar, Control Soak	0.120	< 0.1
Sugar, Control Soak	0.130	< 0.1
No Sugar, Freeze Soak	0.121	< 0.1
Sugar, Freeze Soak	0.147	< 0.1
No Soak, Straight boil	0.659	0.208

*values on as-is basis

4.3.3 Enzyme Inhibitor Activity

Alpha-amylase inhibitor (αAI) is a protein present in the bean species *Phaseolus vulgaris,* which prevents the hydrolysis of starch by alpha-amylase. Inhibition of alpha-amylase activity may cause incomplete gelatinization of starch, which is a major contributing flatulence component when digested by mammals (Bush, et al., 2002). Analyzing the beans for deactivated αAI and reduced oligosaccharides revealed that the chosen treatment (no sugar, control soak) was most effective in fully gelatinizing starch and reducing oligosaccharides. This indicates a potential reduction of flatulence effects in humans consuming beans.

Table 4.5 Alpha-Amylase Inhibitor Activity Results on Two Selected Treatments of Navy Beans

Treatment	AAIU/g *
No Soak, Straight Boil	32.62
No Sugar, Control Soak	< LOD**

*alpha-amylase inhibitor activity; **level of detection

The alpha-amylase inhibitor activity results indicated in Table 4.5 show that the No Sugar, Control soak treatment reduced activity below detection levels. These results indicate that soaking, rinsing and cooking the beans for an appropriate amount of time allows for the reduction of flatulence components.

4.4 Processing Bean Samples for Side Dish Application

4.4.1 Process Modifications for Commercial Processing

In order to make the process more applicable to industry standards, the 12-hr soak and second rinse step originally used were removed. Beans processed using the new process were tested for sugar profile (stachyose and raffinose) and alpha-amylase inhibitor activity to determine if the new process produced similar results. Commercial navy beans from Hanover Foods in the US were used as a comparison to industry practices.

Table 4.6 Oligosaccharide and Alpha-Amylase Inhibitor Activity Analysis Results on FDC Food Lab Processed and Commercial Processed Navy Beans

Bean Sample	Stachyose (%)	Raffinose (%)	AAIU/g*
FDC Food Laboratory Processed	0.274	< 0.1	< LOD**
Commercially Processed	0.468	< 0.1	< LOD

*alpha-amylase inhibitor activity; **level of detection

Based on the results in Table 4.6, it is evident that even with the removal of the 12-hr soak and second rinse step, reduction in oligosaccharides and inhibition of αAI still occurred. It is important to note that the 12-hr soak made a significant difference in oligosaccharide reduction, as the original processing method only resulted in 0.120% stachyose. Although the results of the modified process are not as desirable as the original, inhibition of αAI still occurred and a higher reduction of oligosaccharides was seen compared to commercially processed beans. Removal of the 12-hr soak allows for the process to be more adoptable by industry and the reduction in flatulence components could provide a new marketing strategy. The recommended process is shown in Figure 4.5.

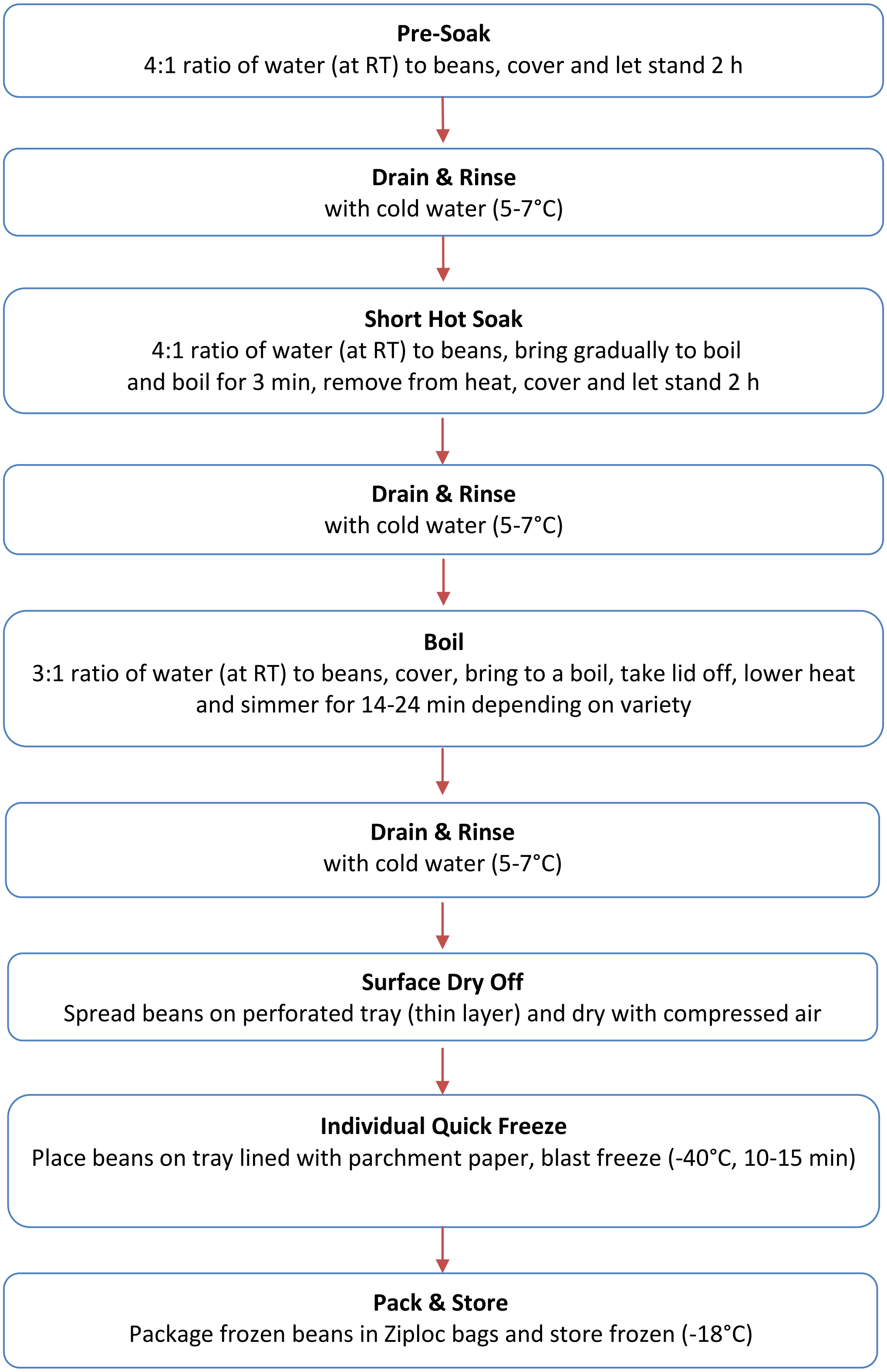

Figure 4.5 Finalized Flow Diagram of Processing Method to Produce Individually Quick Frozen (IQF) Flatulence Reduced Beans

4.4.2 Establishment of Cook Times for Each Bean Type

The cook time for each bean type was determined by using the process outlined in Figure 4.5. During the cooking step, 2-3 trained FDC panelists evaluated the beans for texture and firmness to determine when the beans were optimally cooked (Table 4.7).

Table 4.7 Cook Times for Each Bean Type

Bean Type	Cook Time (min)
Black	14
Pinto	18
Navy	17.5
Soy	24

It is important to note that more splitting and cracking of the stored 2012 crop beans was observed during pre-soaking and cooking. However, less cracking and splitting was observed in earlier process trials, indicating that beans processed shortly after harvest provide a higher quality end product. As the 2012 beans were close to a year old, 2013 crop beans were obtained to continue the research. A local source of 2013 navy beans could not be found, consequently, the existing 2012 crop was used to process beans for the side dishes. Refer to Figures 4.6 and 4.7 for crop year comparison for black and pinto beans produced in 2012 and 2013. Cracking and splitting were not observed in soy beans produced in 2012 (Figure 4.9). Soy beans are more resilient to cooking conditions, which accounts for minimal cracking and splitting during processing (Abu-Ghannam and Gowen, 2011).

Figure 4.6 Black Bean Crop Year Comparison 2012 vs. 2013

Figure 4.7 Pinto Bean Crop Year Comparison 2012 vs. 2013

Figure 4.8 Navy Bean Crop Year 2012

Figure 4.9 Soy Bean crop year 2012

Referring to Figure 4.10, 2012 light red kidney bean crop were eliminated from final prototype testing due to severe splitting during the two hour pre-soak step. Therefore, age of this bean type affects appearance, texture and overall quality more than other bean types. It would be suggested for industry to source and process beans shortly after harvest in order to achieve the best quality. It should be noted that the commercial IQF light red kidney beans were more split and deformed than the other commercial beans.

Figure 4.10 Splitting of Light Red Kidney Beans during 2-hr Pre-Soak

4.4.3 Texture and Colour Analysis for Lab Processed and Commercial Beans

Texture and colour analysis were conducted on four lab processed and four commercial bean types to compare appearance, texture and overall quality.

The three parameters tested for texture were force, area, and gradient. The force is the maximum force the bean can withstand and area is considered the amount of force that is required for deformation. The gradient is the slope or elasticity of the bean. Higher slopes indicate more elasticity in the bean, allowing for more resistance to deformation (Daubert & Foegeding 2010).

Table 4.8 Texture Analyzer Results on Lab Processed and Commercial Beans

Bean Type	Force (g)	Area (g•s)	Gradient (g/s)
Commercial Black	1.23×10^4	9.94×10^4	9.25×10^2
Lab Black	9.03×10^3	1.47×10^5	1.06×10^3
Commercial Pinto	1.29×10^4	9.77×10^4	8.38×10^2
Lab Pinto	1.19×10^4	1.03×10^5	1.16×10^3
Commercial Navy	8.86×10^3	6.40×10^4	5.88×10^2
Lab Navy	9.60×10^3	1.20×10^5	7.18×10^2
Lab Soy	9.31×10^3	1.09×10^5	7.38×10^2

Referring to Table 4.8, commercial black beans had a higher force than laboratory processed beans, indicating the commercial product was firmer overall. The area of the commercial black beans was lower than lab processed having a value of $9.94x10^4$ g•s compared to $1.47x10^5$ g•s, possibly indicating that the skin of the commercial bean was tougher. The commercial black beans also had a lower gradient with a value of $9.25x10^2$ g/s compared to $1.06x10^3$ g/s, which correlates with a lower area. This shows that the beans deformed faster and were not as elastic as the laboratory processed black beans. A reason for this difference could be the use of firming agents, such as calcium chloride in the commercial products.

When comparing pinto beans, force was similar, however area and gradient differed a significant amount. Both the area and gradient of the commercial processed pinto bean were higher, having values of $9.77x10^4$ g•s and $8.38x10^2$ g/s compared with $1.03x10^5$ g•s and $1.16x10^3$ g/s, respectively. Therefore, the commercial pinto beans had more tender skin and more elasticity than the lab processed pinto beans.

For navy beans, force and gradient were similar, indicating similar overall firmness and elasticity. There is a significant difference in area with commercial navy beans having a value of $6.40x10^4$ g•s and lab processed having a value of $1.20x10^5$ g•s. This indicates that the skin of the commercial processed beans were softer than the laboratory processed pinto beans.

There is currently no commercial supplier of IQF mature soybeans in Canada. Therefore, there is no comparison for firmness and texture of the soybeans tested. Although, the texture analysis results of the soybeans are similar to laboratory processed navy beans.

Table 4.8 Minolta Colour Analysis Results on Lab Processed and Commercial Beans

Bean Type	L*	a*	b*
Commercial Black	16.16	5.87	3.16
Lab Black	28.59	8.22	5.48
Commercial Pinto	40.47	9.11	14.47
Lab Pinto	39.12	7.43	9.69
Commercial Navy	67.17	1.72	14.02
Lab Navy	63.22	-0.19	9.71
Lab Soy	65.02	2.47	33.57

The CIELAB system was used to evaluate and compare colour in the commercial and laboratory processed beans. The parameters measured were L*, a*, and b*. L* indicates lightness (0-100), with 0 being black and 100 being white. The parameter a* measures red (+) to green (-) and b* measures yellow (+) to blue (-) (Daubert and Foegeding 2010). Generally, all the beans were similar in colour when comparing commercial and laboratory processed beans. The laboratory black beans were overall lighter in colour than the commercial black beans. Although, the laboratory black beans were very acceptable in appearance.

The laboratory and commercial pinto beans were also similar in colour, but differed on the b* scale. The speckled appearance of the pinto beans may have contributed to this difference.

The commercial navy beans appeared more yellow than the laboratory navy beans, but both were acceptable in appearance.

The difference in colour between the laboratory and commercial beans could be attributed to the use of colour retention processing aids, which causes the commercial beans to be darker and more similar to a freshly cooked bean.

4.5 Conclusions – IQF Beans

A laboratory scale process for IQF beans/soybeans with reduced flatulence potential was developed. Quality of the IQF beans is acceptable compared to commercially processed beans, although no chemical additives were used in this process, which allows the final product to have a clean label. The process conditions developed have the potential to increase the utilization of beans/soybeans, as the equipment requirement is typical for a bean processor and would require minimal capital investment for a new processor (holding tank, kettle and blast freezer). This study indicates great potential for application of the IQF beans/soybeans as ingredients in microwavable side dishes or other food products manufactured by the food industry and food service operations e.g. cafeterias and restaurants. Increased inclusion of beans/soybeans in food products would drive demand for these crops, and potentially increase production acreages and demand for processing facilities, all great for the province of Manitoba. Considering the great nutritional value and health benefits of beans/soybeans, increased consumption of these crops would directly benefit consumers and help combat rising health care costs, as well as, adding value to producer crops and helping to better shape the pulse/soybean value chain.

5.0 RESULTS AND DICUSSION – SIDE DISH DEVELOPMENT

5.1 Side Dish Development

Developing the two side dishes entailed determining suitable bean and bean/soybean blends; sourcing IQF vegetable blends, seasonings, and seasoning adhesion aids; selecting complimentary vegetable blends and seasonings, developing a seasoning application method; establishing microwave reheating methods; and evaluating sensory quality of the side dishes.

5.1.1 Selecting Bean Blends With and Without Soybeans

Various combinations of IQF beans (black, navy, pinto) with and without soybeans were evaluated after microwave reheating for beany flavour and visual appeal by 2-3 assessors. It was observed that some combinations with navy beans exhibited a high level of beany flavour which was considered undesirable. Two bean blends were chosen for development of the prototype side dishes: bean Blend A - black/pinto/navy, and bean Blend B - black/pinto/soy. Both blends contained equal ratios of each bean/soybean.

5.1.2 Selecting IQF Vegetable Blends

Several commercial IQF vegetable blends were evaluated for size, shape, and colour. As the beans were fairly small and oval shaped, smaller sizes/cuts of vegetables were selected to help maintain uniformity of the blended side dish within the package. Brightly coloured vegetables with contrasting shapes complemented the less colourful uniformly shaped beans/soybeans. Two IQF vegetable blends manufactured by Bonduelle, a Quebec-based company, were chosen to formulate the side dishes. Advantage Food Service, a local distributor for Bonduelle, supplied the vegetable blends. Blend 1 (Veggie Pick of the Day) contained julienne orange and yellow carrots and extra fine green beans while Blend 2 (Old Fashioned) was comprised of yellow diced carrots, orange diced carrots, diced celery, cut green beans, and diced onions. It should be noted that while both vegetable blends were considered visually appealing, the appearance of Blend 1 was preferred over that of Blend 2. However, because two distinct side dishes were desired, two vegetable blends were selected.

5.1.3 Combining Vegetable Blends and Bean Blends (With or Without Soybeans)

Bean Blend 1and bean/soybean Blend 2 were combined with vegetable Blends 1 and 2. Flavour, appearance and texture of the four combinations were evaluated after microwave reheating by 2-3 assessors. Combination 3 (black/pinto/navy with Veggie Pick of the Day) and Combination 4 (black/pinto/soy with Old Fashioned) were chosen for evaluation as seasoned side dishes. Figures 5.1-5.4 show photos of the four combinations of vegetables and beans (with and without soybeans).

Figure 5.1 Combination 1: Black/Pinto/Soy with Veggie Pick of the Day

Figure 5.2 Combination 2: Black/Pinto/Navy with Old Fashioned

Figure 5.3 Combination 3: Black/Pinto/Navy with Veggie Pick of the Day

Figure 5.4 Combination 4: Black/Pinto/Soy with Old Fashioned

5.1.4 Seasoning Selection

A variety of gluten-free seasonings from several commercial suppliers were screened by 2-3 assessors for compatibility with the microwaved bean/vegetable blends. Four seasonings (Asian, Indian Masala, Lemon Basil, Sweet and Spicy) from FlavourCan were selected for further screening by a larger untrained sensory panel. These four seasonings were selected because they balanced beany flavour, they had an appealing aroma, flavour and appearance, and they bound excess moisture liberated during microwave reheating.

5.1.5 Selection of Final Side Dishes

To determine which seasonings would be most suitable for the side dishes, bean/vegetable Combination 3 (black/pinto/navy and Veggie Pick of the Day) and bean/soybean/vegetable

Combination 4 (black/pinto soy and Old Fashioned) were each evaluated with the four chosen seasonings.

An untrained 17 member sensory panel ranked seasoning preference for each bean/vegetable combination. Lemon Basil seasoning was most preferred for both bean/vegetable combinations. Therefore, to create two distinct side dishes, the second most preferred seasoning (sweet and spicy) was also selected. Bean/vegetable Combination 3 with Lemon Basil seasoning (side dish A) and bean/soybean/vegetable Combination 4 with Sweet and Spicy seasoning (side dish B) were selected for further evaluation (Table 5.1). Appendix B shows the sensory ballot used to assess seasoning preference for each seasoned bean/vegetable combination.

Table 5.1 Composition of the Final Side Dishes

Side Dish	Bean Types	Seasoning	Vegetable Blend
A	Black, Pinto, Navy	Lemon Basil	Veggie Pick of the Day
B	Black, Pinto, Soy	Sweet and Spicy	Old Fashioned

Based on the results of the preference test, further sensory testing was conducted with a 14-member untrained panel to assess likeness of overall appearance, aroma, texture, flavour and quality of the two side dishes. Sensory results for likeness are given in Table 5.2.

Table 5.2 Average Likeness Scores[1] for Sensory Attributes of Side Dishes "A" and "B"

Attribute	Dish "A"Score	Dish "B" Score
Appearance	6.29	5.86
Aroma	6.07	6.14
Texture	6.50	6.29
Flavour	6.43	6.00
Quality	6.36	6.07

1 A rating of 1 = very much dislike and 7 = very much like

The likeness scores show both side dishes were moderately liked (6 out of 7) for all attributes except for aroma of side dish B which was rated slightly lower than that of side dish A. Panelists commented on their likeness of the buttery and spicy aroma of side dish A. Spiciness of side dish B was also noted by a few panelists who stated they would rank their likeness higher if the dish was less spicy. Many panelists commented that they enjoyed the texture of the beans in contrast to the vegetables and that the overall appearance was pleasant.

5.1.5 Microwave Heating Method

The IQF format of the side dishes allows consumers to microwave single or multiple portions of the side dish. The following microwave reheating instructions were used to prepare the side dishes for evaluation: 1) Place one frozen 100g portion (3/4 cup) of the side dish in a microwave safe container. 2) Cover and microwave for one minute on high power in the microwave. A 1500 watt General Electric Profile consumer microwave (Model JE2160FSC) was used. Heating times should be adjusted for different wattage microwaves or when reheating multiple portions of the side dishes.

5.1.6 Process Development

Manufacturers of seasoned IQF side dishes can topically apply the seasoning to the frozen ingredients or the seasoning can be blended/tumbled with the frozen ingredients. Topical application of the seasoning was the method used for this research. In commercial manufacturing, IQF beans and vegetables would move along a conveyer belt passing under a water mister and then a seasoning applicator before being packaged. A spray bottle was used to mist the frozen ingredients with a 10% solution of N-tack, a waxy corn starch specialty product manufactured by Ingredion (formerly National Starch), used to adhere the seasoning to the beans/soybeans and vegetables.

N-tack was selected due to its low viscosity, frozen appearance, and ability to adhere seasonings and particulates. Higher concentrations of the N-tack solution were too viscous and difficult to mist onto the product. Approximately 3% of the N-tack solution was applied to adhere 4% seasoning. The seasoning pick up was approximately 68-70% of the amount applied. Higher pick up was not possible using this method but the seasoning level was deemed to adequately flavour the product. The amount of each side dish component is given in Table 5.3.

Table 5.3 Side Dish Formulation based on 120g serving size

Ingredient	Amount (g)	% of Formulation
Bean Blend	60 (20g of each bean)	47.06
Vegetable Blend	60	47.06
Seasoning	4	3.14
10% N-tack Solution	3.5	2.75
Total	**127.50**	**100**

5.2 Nutritional Information

The developed side dishes are ideal for health conscious consumers, those with health issues such as celiac disease and diabetes, consumers who follow specific diets such as vegetarians and vegans, and those seeking non GM products.

Both prototype side dishes are low glycemic products that are very high in fibre, low in fat, and moderately high in protein. The bean/soybean side dish (A) is also low in sodium while the bean side dish (A) is allergen-free. These factors suggest that the side dishes would have wide market appeal.

Figures 5.5 and 5.6 display Canadian Nutrition Facts Tables (NFTs) for side dishes A and B, respectively. The ingredient listing and nutrient related claims for each side dish are provided after the product's NFT.

5.2.1 Pulse Vegetable Side Dish "A"

Nutrition Facts Valeur nutritive Per 3/4 cup (100 g) / par 3/4 tasse (100 g)	
Amount **Teneur**	**% Daily Value** **% valeur quotidienne**
Calories / Calories 80	
Fat / Lipides 0.5 g	**1** %
Saturated / saturés 0.2 g + Trans / trans 0 g	**1** %
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 190 mg	**8** %
Carbohydrate / Glucides 17 g	**6** %
Fibre / Fibres 8 g	**32** %
Sugars / Sucres 1 g	
Protein / Protéines 5 g	
Vitamin A / Vitamine A	6 %
Vitamin C / Vitamine C	0 %
Calcium / Calcium	8 %
Iron / Fer	15 %

Figure 5.5 Canadian Nutrition Facts Table for Pulse Vegetable Side Dish "A"

INGREDIENTS: BLACK BEANS, PINTO BEANS, NAVY BEANS, CARROTS, GREEN BEANS, LEMON BASIL SEASONING (MALTODEXTRIN, SALT, SUGAR, NATURAL FLAVOUR, SPICES, ONION, GARLIC, YEAST, TUMERIC, CITRIC ACID, CALCIUM SILICATE), CORN SYRUP SOLIDS

Canadian Nutrient Content Claims for Pulse Vegetable Side Dish “A”:

- Low in Fat
- Low in Saturated Fatty Acids
- Free of Trans Fatty Acids
- Free of Cholesterol
- Very High Source of Fibre
- Source of Calcium and Iron

Canadian Health Claim for Pulse Vegetable Side Dish “A”:

“A healthy diet in low saturated and trans fats may reduce the risk of heart disease. Pulse Vegetable Side Dish “A” is low in saturated and trans fats”.

5.2.2 Pulse/Soybean Vegetable Side Dish” B”

Nutrition Facts
Valeur nutritive
Per 3/4 cup (100 g) / par 3/4 tasse (100 g)

Amount Teneur	% Daily Value % valeur quotidienne
Calories / Calories 80	
Fat / Lipides 2 g	**3** %
Saturated / saturés 0.4 g + Trans / trans 0 g	**2** %
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 110 mg	**5** %
Carbohydrate / Glucides 14 g	**5** %
Fibre / Fibres 8 g	**32** %
Sugars / Sucres 1 g	
Protein / Protéines 7 g	
Vitamin A / Vitamine A	4 %
Vitamin C / Vitamine C	0 %
Calcium / Calcium	4 %
Iron / Fer	8 %

Figure 5.6 Canadian Nutrition Facts Table for Pulse Vegetable Side Dish “B”

INGREDIENTS: BLACK BEANS, PINTO BEANS, SOYBEANS, CARROTS, CELERY, GREEN BEANS, ONIONS, ASIAN BLEND SEASONING (SUGAR, SALT, NATURAL FLAVOUR, YEAST, SESAME, ONION, GARLIC SPICES, PAPRIKA, CALCIUM SILICATE), CORN SYRUP SOLIDS

ALLERGENS: SOY, SESAME

Canadian Nutrient Content Claims for Pulse Side Dish "B":

- Low in Fat
- Low in Saturated Fatty Acids
- Free of Trans Fatty Acids
- Free of Cholesterol
- Low in Sodium/Salt
- Very High Source of Fibre
- Source of Iron

Canadian Health Claim for Pulse Vegetable Side Dish "B":
"A healthy diet in low saturated and trans fats may reduce the risk of heart disease. Pulse Vegetable Side Dish A is low in saturated and trans fats".

Note: Any claims made for the blends must use the exact wording stated above.

5.3 Packaging

For consumer convenience and storage stability, the recommended package is a high barrier resealable pouch. High barrier packaging helps prevent moisture and oxygen migration thus helping to preserve nutrients and product quality. Resealable packaging allows consumers to prepare a portion of the contents and store the remainder.

5.4 Conclusions – Side Dishes

IQF Manitoba beans (black, navy, and pinto) and non GM soybeans that are processed to reduce flatulence can be combined with IQF vegetables and seasonings to produce microwavable side dishes that are gluten-free, non-GM, nutritious, and tasty with wide market appeal. It is possible to incorporate a high percentage of beans/soybeans (approximately 50%) into the side dishes. High likeness scores for the prototypes suggest that seasoned side dishes containing a 1:1 ratio of beans/soybeans to vegetables could be successful in today's marketplace as premium products providing superior nutrition and health benefits.

Incorporating soybeans into the bean blend increases protein levels but it also introduces an allergen. While IQF dry soybeans are not commercially available, they performed very well in this application suggesting a new opportunity exists in North America for value-added soybeans.

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APPENDIX A. MOISTURE CONTENT, WEIGHT GAIN AND APPEARANCE RATINGS FOR BEANS/SOYBEANS SOAKED FOR 12 AND 18 H

Table A.1 Moisture content, weight gain (water uptake) and appearance ratings for beans/soybeans soaked for 12 h.

Sample	Moisture Content (%)	Weight Gain %	Appearance Rating (1-5)
Beans			
Maverick	43.63	38.2	3
Floyd	37.75	61.2	4.5
Pink Panther	55.97	87.1	4.6
Foxfire	54.02	89.8	4.8
Envoy	54.66	81.2	4.3
AC Earlired	46.45	37.1	2.5
Eclipse	56.22	95.4	4.3
UI 911	56.64	100.2	4.5
Windbreaker	53.24	83.3	4.3
T99 03	49.67	73.4	4
FDC Brown	55.79	93.0	4.7
Viterra*	54.14	87.8	4.6
FDC Black	56.22	94.4	4.4
Soybeans			
Roy OAC Prudence	56.83	87.3	4
SunOpta Prudence	48.58	76.5	4
SunOpta Erin	60.54	120.6	4.8

Table A2. **Moisture content, weight gain (water uptake) and appearance ratings for beans/soybeans soaked for 18 h.**

Sample	Moisture Content (%)	Weight Gain %	Appearance Rating (1-5)
Beans			
Maverick	56.4	73.7	4
Floyd	55.4	97.2	5
Pink Panther	57.2	107.0	4.8
Foxfire	54.7	105.7	4.8
Envoy	54.3	92.9	5
AC Earlired	56.4	94.1	4
Eclipse	57.3	103.0	4.3
UI 911	58.4	106.7	3.8
Windbreaker	56.9	99.3	4.5
T99 03	55.3	80.7	4
FDC Brown	61.2	106.0	4.8
Viterra*	55.2	91.0	4.5
FDC Black	58.6	99.7	3.8
Soybeans			
Roy OAC Prudence	62.4	113.9	3.5
SunOpta Prudence	62.1	108.7	3.8
SunOpta OAC Erin	61.7	127.8	5

APPENDIX B. SENSORY BALLOT USED BY UNTRAINED PANEL TO RANK SEASONING PREFERENCE FOR TWO PUSLE VEGETABLE SIDE DISHES WITH FOUR DIFFERENT SEASONINGS

Sensory Evaluation
Pulse Vegetable Side Dish Seasoning Preference

PART A

Evaluate the pulse vegetable side dishes in the order presented below from left to right. Eat a cracker and drink water in between each sample to cleanse pallet. You may sample each dish more than once after evaluating all four dishes.

408 **528** **157** **387**

Please rank the four samples in order of overall preference (1 = most preferred; 4 = least preferred) and state your reasoning for the ranking (ie. flavour, appearance, etc).

1: ______________________________
Comments:____
____
____

2: ______________________________
Comments:____
____
____

3: ______________________________
Comments:____
____
____

4: ______________________________
Comments:____
____
____

PART B

Please answer the following question by circling your answer.
Based off your top choice, how would you rank your likeness of this product?

1	2	3	4	5	6	7
Very Much Dislike	**Moderately Dislike**	**Slightly Dislike**	**Neither Like or Dislike**	**Slightly Like**	**Moderately Like**	**Very much Like**

APPENDIX C. BALLOT USED BY UNTRAINED PANEL TO ASSESS LIKENESS OF SENSORY ATTRIBUTES FOR PULSE VEGETABLE SIDE DISHES

Sensory Evaluation
Likeness of Pulse Vegetable Side Dish Attributes

You are presented with a pulse vegetable dish sample. Please evaluate your likeness of the sample.

Circle your likeness for overall appearance, aroma, texture, flavour, and quality and comment on any attribute you wish.

Note: This ballot has two sides. Please flip over to complete the evaluation.

OVERALL APPEARANCE

1	2	3	4	5	6	7
Very Much Dislike	**Moderately Dislike**	**Slightly Dislike**	**Neither Like or Dislike**	**Slightly Like**	**Moderately Like**	**Very much Like**

Comments:____
____
____

OVERALL AROMA

1	2	3	4	5	6	7
Very Much Dislike	**Moderately Dislike**	**Slightly Dislike**	**Neither Like or Dislike**	**Slightly Like**	**Moderately Like**	**Very much Like**

Comments:____
____
____

OVERALL TEXTURE

1	2	3	4	5	6	7
Very Much Dislike	**Moderately Dislike**	**Slightly Dislike**	**Neither Like or Dislike**	**Slightly Like**	**Moderately Like**	**Very much Like**

Comments:____
____
____

OVERALL FLAVOUR

1	2	3	4	5	6	7
Very Much Dislike	**Moderately Dislike**	**Slightly Dislike**	**Neither Like or Dislike**	**Slightly Like**	**Moderately Like**	**Very much Like**

Comments:____
____
____

OVERALL QUALITY

1	2	3	4	5	6	7
Very Much Dislike	**Moderately Dislike**	**Slightly Dislike**	**Neither Like or Dislike**	**Slightly Like**	**Moderately Like**	**Very much Like**

Comments:____
____
____