

Development of Globix: A New Bean-based Pretzel-like Snack

Winner of the 2007 AACC International Student Division Product Development Competition



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- Their products, Globix, are crunchy sticks comprising a balanced combination of whole wheat and whole navy bean flours.
- Globix represent the multiculturalism of North American society, bringing together diverse flavors from around the globe, such as jalapeno, creamy dill, mild curry, and wasabi.
- Globix aim to please those who appreciate the best seasonings of the planet in a healthy, convenient, and unique product.

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Globix are crunchy sticks comprising a balanced combination of whole wheat and whole navy bean flours. They introduce jalapeno, creamy dill, mild curry, and wasabi flavors aimed to please those who appreciate the best seasonings of the planet in a healthy, convenient, and unique product. Globix offer a colorful and shiny appearance (Fig. 1) with a delightfully crunchy texture, bringing a new concept to healthy and flavorful snacks.

Innovating with Beans

The common bean (*Phaseolus vulgaris* L.) is low in fat and rich in proteins, vitamins, complex carbohydrates, and minerals. More than contributing basic nutri-

tional requirements, dry bean consumption has been inversely associated with development of some important Western diseases, such as heart disease (22), obesity (8), and cancer (5).

The production and export of beans in North America has increased appreciably in the last decade, which qualifies them as a crop of economical significance. In Canada, the world's fourth largest bean producer, beans are mostly harvested in the provinces of Manitoba and Ontario, where 90% of the product is exported (2).

Processing of beans into value-added foods is still quite limited in the Western world. Nonetheless, due to their exceptional nutritional properties, it appears that beans are a potential ingredient for the de-



Fig. 1. The colorful and shiny appearance of Globix in various flavors.

velopment of functional foods and nutraceuticals (18).

Incorporating legume flour in the formulation of staple foods made from wheat flour does not seem an easy task. Bean flour, for instance, has been reported to cause a strong negative impact on dough rheology and organoleptic properties of bread (6). On the other hand, it has been successfully added to corn tortillas in levels as high as 50% (11).

Nowadays, a very limited number of industrialized snack foods containing legumes are found in the marketplace. Conversely, the demand for healthier snacks appears to point skywards (3).

Formulation and Processing

The formulation of the plain sticks is listed in Table I. After drying, sticks were coated with coating solution and seasoning (Table II) at 15% by weight. The corn syrup solids and the modified starch used for coating were donated by the Grain Processing Corporation (Muscatine, IA). The seasonings, navy bean flour, and whole wheat flour were provided by Griffith Laboratories (Toronto, Canada), Agri-Food Research and Development Initiative (ARDI) (Morden, Canada), and Canadian Grain Commission (Winnipeg, Canada), respectively. In addition, vital gluten and baking powder were purchased in a local supermarket.

Globix were manufactured using a laboratory scale twin screw extruder (APV Baker Ltd., Peterborough, UK) under low temperature (77°F) and low shear (Fig. 2). Premixed dry ingredients were added to

the feed hopper and water was injected (12.5 g/min) as the mixture reached the screw zone (feed rate: 51.8 g/min). Under such conditions, Globix were produced in a continuous process, increasing productivity and reducing production costs. Globix are simple and relatively easy to manufacture and can be manufactured in pretzel or pasta extruders.

After exiting the extruder die, moist dough (24% moisture) was cut into 2-inch sticks and proofed for 5 min in a high moisture environment before drying in a

Table I. Formulation of plain Globix (previous to coating)

Ingredient	Amount (%)
Whole wheat flour	37.5
Navy bean flour	34
Water ^a	24
Corn syrup solids	2.8
Vital gluten	1.1
Baking powder	0.6

^a Injected during extrusion.

Table II. Formulation of Globix coating solution

Ingredient	Amount (%)
Water	58
Modified starch ^a	18
Seasoning ^b	15
Corn syrup solids ^a	9

^a Part of coating solution prepared following recommendations of manufacturer.

^b Commercial snack seasoning provided by industry suppliers (maltodextrin, 19% NaCl, dextrose, milk solids, flavor, onion powder, citric acid, garlic powder, spice).

convection oven (Moffat Ltd., Ontario, Canada) at 300°F for 10 min. Dried and cooled sticks were coated in a coating tumbler (Leeson Ltd., Grafton, WI) for 5 min. The coating solution was prepared as suggested by the manufacturer (Grain Processing Corporation, Muscatine, IA). Coated sticks were returned to the oven at 300°F for 3 min, cooled for 5 min, and packaged.

Globix on Nutrition

Globix are exceptional in their nutritional properties, being a high-fiber, good source of protein and fat free. Its nutrient content estimation is shown in Figure 3 (20,21). These features represent our innovative approach to combining the flavors and nutritional attributes of wheat and navy bean whole grain flours.

The addition of bean flour to whole wheat flour caused an increase in the pro-



Team Globix, from left to right: Fernando B. Luciano, Lili Zhang, Arshala Madapathage, Daiva Daugelaite, Da An, Alex A. Anton, Lini Qiao, Caroline F. Rosa, Heather Maskus, Blanca Gómez, and Nikolay Repin (in the front).

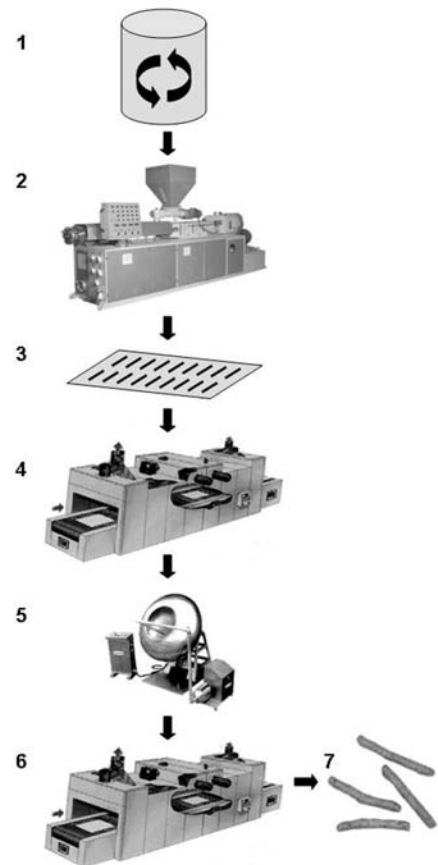


Fig. 2. Globix processing flowchart. 1—Premixing of whole wheat flour, navy bean flour, and baking powder. 2—The extruder mixes the dry ingredients and water forming a dough and gives the final shape of the product, cutting them into 2-inch sticks. 3—Five min proofing in a high moisture environment. 4—Ten minutes baking at 300°F. 5—Dried sticks are coated in a tumbler. 6—Three min back in the oven (300°F) for coating drying. 7—After a 5 min cooling period, Globix are ready to be packaged.

tein content of the final product since legumes generally contain more proteins than cereals (19). Although amino acids were not evaluated, the literature shows that the addition of legume flour on wheat flour baked products improves the essential amino acid balance of such foods (16). Because cereal grains lack lysine, the addition of pulses, which are rich in protein and particularly high in this amino acid, enhances the protein quality of the final product (13). Bread, for example, has been reported to have its protein quality improved by the addition of 10, 15, or 20% of broad bean flour to wheat flour in an Egyptian bread formulation (16).

Globix are fat free because they are coated with a solution of modified starch and corn syrup solids, avoiding the use of oil traditionally used for coating snacks. Although the levels of sodium are relatively high due to coating mixtures, it could be easily and effectively reduced by replacing regular salt with a low sodium option.

Packaging

Globix were packaged in multi-layer plastic bags. The laminated layers included: O-PP/met-PET/LDPE (oriented polypropylene/metallized polyethylene terephthalate/low-density polyethylene),

which combines the best properties of these polymers. The first, outer O-PP layer provides an inexpensive plastic with good printable characteristics (7), whereas the next layer, met-PET, acts as a barrier for moisture and light. These barriers are important to maintain the color and other organoleptic characteristics of the flavorants used, such as odor and taste. Moreover, the moisture barrier is also needed to keep the sticks' original texture, since Globix is fat-free and can be easily dried if in contact with environmental moisture. A barrier for oxygen is not needed in this product, since rancidity is not an issue to the fat-free Globix sticks. Lastly, LDPE is a low-density polymer with excellent sealing properties and low cost (15). These bags are able to maintain the freshness of Globix at a reasonable cost.

In addition, the packaging system is fastened with the production line, using an automatic vertical form-fill-seal machine (10). Globix bulk density was surveyed as 0.35 g/cm³ and, therefore, the 50 g packages are smaller than the traditional puffed snacks, giving an advantage on transportation cost.

Safety and Shelf Life

Globix were manufactured following the guidelines and principles of HACCP. Although wide use of dry beans (*Phaseolus vulgaris* L.) in human and animal nutrition has been limited by the presence of trypsin inhibitors (TI) in raw seeds (1),

Globix are safe for human consumption because levels of TI have been effectively reduced during processing. Analysis of the raw mixture and the final products has shown that TI were reduced by 90% (5938.36 to 585.7 trypsin inhibitory units/g DM, n = 4) (9). We also tested precooking of beans using micronization, but no significant differences were found between levels of TI in the final products of raw or micronized flours, and the most cost-effective procedure was chosen. It will be clearly declared on the package that Globix contain gluten and other potential allergens such as whey.

Based on the nature of the ingredients, on the water activity level (0.157, n = 3), and on the moisture content (3.96%, n = 3) detected in the final product, the forecast shelf life of Globix is 180 days.

Marketing Plan and Potential

Globix will enter the North American snack food market, which also includes potato chips, tortilla chips, hard pretzels, popped popcorn, processed seed snacks, pork rinds, and roasted peanuts and other nuts (3), where pretzels, popcorn, and chips account for 75% of the market share (14). The market totaled \$16 billion in 2000 (12) and is growing at approximately 3% a year (17). Considering the market growth and trends toward convenient (3) healthy snack (3,12,14) foods and the use of ethnic flavors (2, 3) to satisfy an increasingly diverse culture, Globix will be

Nutrition Facts

Serving Size : 48 sticks (50g)
Servings Per Container 1

Amount Per Serving

Calories 160 Calories from Fat 5

% Daily Value*

Total Fat 0g 0%

Saturated Fat 0g 0%

Trans Fat 0g

Cholesterol 0mg 0%

Sodium 500mg 21%

Total Carbohydrate 32g 11%

Dietary Fiber 8g 32%

Sugars 2g

Protein 8g

Vitamin A 0% • Vitamin C 0%

Calcium 8% • Iron 15%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories	2,000	2,500
Total Fat	Less Than	65g	80g
Saturated Fat	Less Than	20g	25g
Cholesterol	Less Than	300mg	300 mg
Sodium	Less Than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Fig. 3. Nutrition label information for Globix. Reference daily intake for vitamins or minerals and daily reference values for protein and fiber acquired from FDA (21,22).

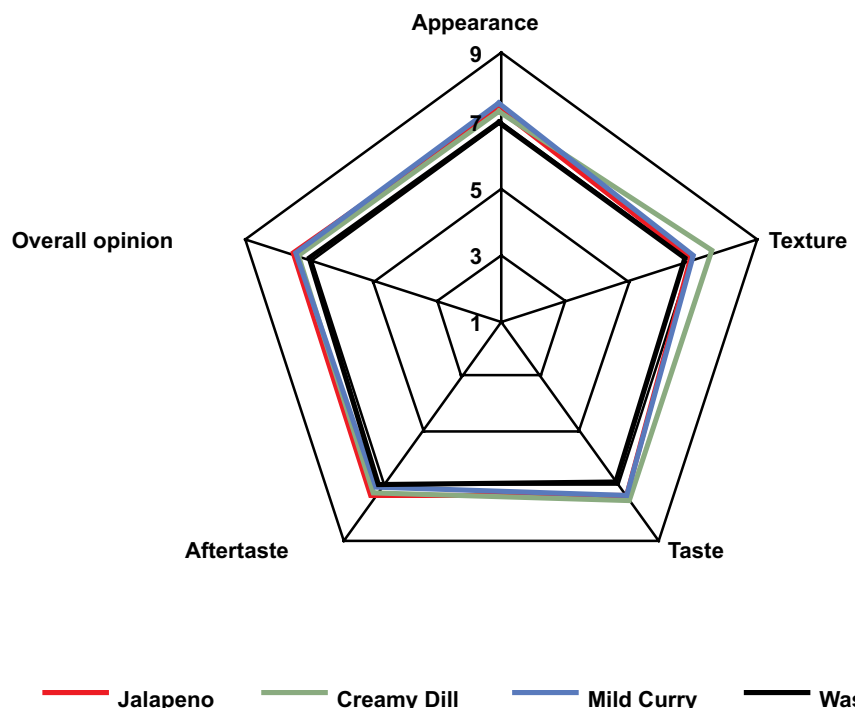


Fig. 4. Consumer acceptance results of preliminary Globix product by 43 untrained panellists on a nine point hedonic scale (1—dislike extremely, 5—indifferent, 9—like extremely).

able to gain a market share considering that the product is sold in individual serving sized bags, is low in fat, and high in both fiber and protein while available in four ethnic flavors. In 1997, 12.35% of the \$13.76 billion dollar snack food market was made of healthful snacks (17). Consumer pressure on food companies to provide healthier snacks is growing. This will provide Globix the opportunity to gain some of the snack food market share.

Globix healthy and crunchy sticks are marketed to appeal to the 20–35-year-old demographic. It was found in an interview

with McCormick that people between 18 and 24 appreciate flavors between bland and bold while people between the ages of 25 and 35 prefer strong flavors that have ethnic or regional traits (4). Milder flavors of Globix include curry and creamy dill, while jalapeno and wasabi will satisfy the palates of people who prefer bolder flavors. More specifically, the target market must be health conscious and choose food products that represent this lifestyle as well as be aware of global trends and flavors. The results for a preliminary sensory analysis are shown in Figure 4. This indicates that Globix, in its early stages, was considered an acceptable product by 43 untrained panelists. The flavor with the greatest overall acceptance was jalapeno while the flavor with the lowest overall acceptance was wasabi. Further improvement of the product was carried out following this sensory analysis.

With a large distribution network for snack foods, Globix will be located in a variety of convenient locations including retail outlets such as grocery stores, book stores, music stores, and health food stores. Agreements with food service will also be reached in order to sell Globix on university and college campuses. Sporting events will also carry Globix to satisfy as a snack during recreational, university, and professional games. Other convenient locations where Globix will be sold include vending machines and at gym concessions. The Globix retail goal is to enter the market of airline snack foods.

The product is intended to be launched initially in Canada, and following that, the United States. The suggested retail price of \$1.25/bag (50 g package) is based upon a competitive market pricing strategy. Other commercial pretzels were found to be priced at \$0.99 per 100 g package. The increase in cost of Globix is accounted for by the increased cost of navy bean flour relative to wheat flour, the cost of having less product per package, and the additional promotional costs of a new product.

Promotion will be of the greatest importance in the success of Globix. Although popcorn and pretzels are considered a healthy snack food, promotional efforts need to be developed and implemented to remind health-minded consumers that there are relatively healthy snack foods in order to increase the sales of these foods (14). Baked potato chips have recently divided the sales of the healthy snack food market, which caused a decrease in pretzel sales in 1996 (4). Some promotional efforts that will be implemented include the use of coupons, promotional giveaways, and sponsorship of student events, (e.g., orientation week) as well as advertise-

ments in television, radio, newspapers, and magazines.

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The Future

As the demand for healthier snacks grows, new attempts to improve the nutritional quality of conventional snacks appear more and more often in the scientific literature, slowly making their ways to the supermarket shelves. Due to its relevant nutritional composition and related health benefits, the incorporation of legume flours into highly processed snacks appears to be promising. Nevertheless, the development of edible materials with high consumer acceptability from alternative ingredients is at least challenging to the cereal scientist and food technologist alike. From this perspective, a multidisciplinary approach with the collaboration of nutrition, chemistry, and rheology professionals would probably be the best choice.

From such a diverse group of food scientists, we succeeded in overcoming the barriers of producing a dough with acceptable cohesiveness and a final product that was “crunchy” in its texture and “shiny” in its appearance, yet tasting as mild curry, wasabi, creamy dill, or jalapeno, with no resemblance of beans whatsoever. We hope to see similar ideas in our groceries stores, university canteens, and vending machines soon.

Acknowledgments

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A total of six teams participated in the 2007 AACC International Student Division Product Development Competition. The submitted products ranged from blueberry wafer rolls to a high fiber, black bean- and flax seed-infused bread. A total of \$6,000 in prize money was awarded to the top three teams and \$900 in travel money was also awarded.

First place:

Globix

University of Manitoba

Team members: Da An, Alex A. Anton, Daiva Daugelaite, Blanca Gómez, Fernando B. Luciano, Arshala Madapathage, Heather Maskus, Lini Qiao, Nikolay Repin, Caroline F. Rosa, and Lili Zhang

Second place:

BlueberryCrisp

Cornell University

Team: Dongjun Zhao

Third place:

Hi-Be Bread

Purdue University

Team: Yanyun Chen, Cynthia Machado, and Shriram Paranjpe

Other teams:

Cran Cranberries Mini

Michigan State University

Team: George Nyomba and Aileen Tanojo

Olla

Rutgers University

Team: Maureen Evans, Alyson Mandeville, Katherine Nolen, and Xuntao Zhu

Start Right Cereal

Texas A&M University

Team: Nenge Lynda Njongmeta and Nathan Poland

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Alex Anton, who is originally from Florianopolis, Brazil, is currently working on his master's in the Department of Food Science of the University of Manitoba, Canada. He graduated in pharmacy in 2003 and in food science and technology in 2006 in the Federal University of Santa Catarina, Brazil. In Canada, his work focuses on the development of snack foods with demonstrated health benefits from common beans (*Phaseolus vulgaris* L.), which is supervised by Susan Arntfield. In 2007, Alex was awarded the Elizabeth Paterson International Student of the Year (Canada), an AACC International Foundation Fellowship Award, the James Gordon Fletcher Graduate Fellowship in Agricultural and Food Sciences, and the 6th European Conference on Grain Legumes Fellowship. He is passionate for traveling, a voracious reader, and an aspirant travel writer. Alex can be reached at alexanton2002@gmail.com.



Originally from Joinville, Brazil, **Fernando Luciano** is currently enrolled in the master's program at the Department of Food Science, University of Manitoba, Canada. He holds two B.Sc. degrees, pharmacy (2003) and food science and technology (2005), both from the Federal University of Santa Catarina, Brazil. He worked for 1.5 years as a research analyst for Banana Brasil Caui Ltd., Brazil, where he led the development of six new food products marketed internationally. In his master's, Luciano researches about the mechanism of action underlying the bactericidal effect of allyl isothiocyanate (oil from mustard seed) against *Escherichia coli* O157:H7. Luciano has received several awards during his academic life and more recently was awarded with the Manitoba Graduate Scholarship and the University of Manitoba Graduate Fellowship. Fernando can be contacted at fbluciano@gmail.com.



Born in Winnipeg, MB, Canada, **Heather Maskus** is working on her M.Sc. at the Food Science Department of the University of Manitoba. Her thesis, "The inclusion of dry field peas (*Pisum sativum*) in tortillas and expanded snack food extrudates," is under the advisement of S. Arntfield. Heather's B.Sc. (food science) was completed in 2006 at the University of Manitoba. She has received the James Barlow Fellowship and was awarded first prize for her pulse research at the Pulse Research Workshop in 2006. Heather is a member of the executive council of the Canadian Institute of Food Science and Technology. Her e-mail is ummasku2@cc.umanitoba.ca.