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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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.

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 nutritional 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 development of pretzel-like snacks.
velopment of functional foods and nutracu-
ticals (18).
Incorporating legume flour in the for-
mulation 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 lev-
eels as high as 50% (11).
Nowadays, a very limited number of in-
dustrialized snack foods containing le-
gumes are found in the marketplace. Con-
versely, 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 season-
ing (Table II) at 15% by weight. The corn
syrup solids and the modified starch used
for coating were donated by the Grain Pro-
cessing 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 lab-
oratory 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 produc-
tivity and reducing production costs. Glo-
lix are simple and relatively easy to man-
ufacture and can be manufactured in pret-
zel 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
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 Pro-
cessing 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 nutri-
tional 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 inno-
vative 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-

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount (%)</th>
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<tbody>
<tr>
<td>Whole wheat flour</td>
<td>37.5</td>
</tr>
<tr>
<td>Navy bean flour</td>
<td>34</td>
</tr>
<tr>
<td>Water</td>
<td>24</td>
</tr>
<tr>
<td>Corn syrup solids</td>
<td>2.8</td>
</tr>
<tr>
<td>Vital gluten</td>
<td>1.1</td>
</tr>
<tr>
<td>Baking powder</td>
<td>0.6</td>
</tr>
</tbody>
</table>

\* Injected during extrusion.

Table II. Formulation of Globix coating solution

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>58</td>
</tr>
<tr>
<td>Modified starch*</td>
<td>18</td>
</tr>
<tr>
<td>Seasoning#</td>
<td>15</td>
</tr>
<tr>
<td>Corn syrup solids#</td>
<td>9</td>
</tr>
</tbody>
</table>

\* Part of coating solution prepared following recommendations of manufacturer.
\# Commercial snack seasoning provided by industry suppliers (maltodextrin, 19% NaCl, dextrose, milk solids, flavor, onion powder, citric acid, garlic powder, spice).

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).
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/cm$^3$ 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 for Globix]

**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).

![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).]

**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 disappeared from similar ideas in our groceries stores, and thereby products. 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.

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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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