

SOY FLOUR PRODUCTS IN BAKING

Clyde E. Stauffer, Ph.D.
Technical Foods Consultants

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CHAPTER 1. INTRODUCTION

Soybeans have been grown and used as human food for nearly 5000 years, beginning in China and now widespread in Far Eastern countries. Soybeans are rich in protein and are an inexpensive alternative to animals and fish as a source of dietary protein. Their oil content is higher than that of cereal grains and most other legumes, hence they are a good source of calories. Today soybeans account for well over half of total worldwide oilseed production; the United States produces nearly half the total but there is significant production in Brazil, China and Argentina.

Most soybeans are processed in crushing plants where extraction separates them into oil and meal. The high protein content of soy meal makes it a valuable component of formulated animal feeds (the major market for meal) but some of it is processed for human consumption. Oil is mainly processed for human use as refined vegetable oil or partially hydrogenated for shortenings and margarines. Other industrial uses (e.g. diesel fuel, printing inks) are becoming important commercial outlets.

Defatted soy flour is the form of soy protein most widely used by food processors (bakers in particular). The addition of soy protein to wheat flour increases the protein content and improves the amino acid balance in the food, providing a more nutritious product. This is especially significant for consumers with a limited protein intake who obtain the majority of their dietary protein from bread.

Soy flour displays several desirable functions during processing in the bakery. It absorbs water (during mixing) and retains moisture (through the bake). The additional water increases bread yield and moisture retention extends product shelf life. Other desirable functions are discussed below. In general the addition of soy flour to a dough or batter requires few (if any) adjustments in bakery processing operations (mixing, dividing, etc.). The bakery food usually looks, tastes, and smells just like the product without soy flour. Product quality such as crumb whiteness and crust color is often improved.

Texturized soy protein is made by extruding soy flour or soy protein concentrate to make a high protein meat extender or replacement. Extruded soy flour in flake form, called texturized vegetable protein (TVP), is sold on supermarket shelves for use by the housewife as a meat extender in dishes prepared at home.

This booklet is a brief introduction to the use of soy flour in the bakery.

CHAPTER 2. PROCESSING AND PRODUCTS

Most soybeans are processed at a crushing plant. At this facility the moisture content of the beans is adjusted to below 10%, then the hulls (the outer layer) are removed. The centers are broken into four to eight pieces that are flaked, and the oil is extracted using hexane. The crude oil is sent to refiners, while the extracted meal is further treated for animal or human consumption. (The hulls are primarily fiber -- cellulose and hemicellulose -- and are usually included with meal intended for animal feed.) The small amount of solvent remaining on the meal is removed to give Defatted Meal. This may be toasted, then ground into Defatted Soy Flour.

Washing the defatted meal with a water solvent removes most of the soluble sugars to make Soy Concentrate. Using a different method removes all the sugars and fiber to give Isolated Soy Protein. Due to additional processing costs these products are generally too expensive for ordinary bakery use.

A small percentage of beans are processed using extrusion technology. The moisture content of the beans is raised during steaming, then mechanical pressure is used to remove most of the oil. The residual meal is used as is, or it may be flaked by a second extruder. The meal (or flakes) is then dried. The Semi-defatted Meal contains 6 - 8% residual oil.

Soybeans may be simply ground to make Full Fat Soy Flour. This is less expensive, contains an enzyme (lipoxygenase), and has some application as a bread additive.

Composition.

Soybeans comprise about 8% hull, 2% hypocotyl (germ) and 90% cotyledon. The proximate analysis of soy products at various stages of processing is given in Table 1.

TABLE 1. TYPICAL SOY PRODUCT COMPOSITION

	Soybeans	Dehulled Beans	Defatted Meal	Soy Concentrate	Isolated Soy Protein
Moisture, %	11	10	8	5	5
Protein, %	36	40	50	66	91
Oil, %	20	22	<1	<1	~0
Ash, %	5	6	7	5	4
Carbohydrates, %	28	22	35	23	~0
Dietary fiber, %	21	16	19	21	~0

Toasting.

Soy flakes are toasted at several different levels before grinding, depending upon the intended application. Lightly heated soy flour contains lipoxygenase and other enzymes and is useful as a dough conditioner and crumb bleaching agent. This is referred to as 90 PDI Defatted Soy Flour. Most soy flour for baking applications is lightly toasted. This inactivates lipoxygenase and increases the storage stability of the flour. It also removes some of the beany flavor notes present in untoasted soy meal. This is called 70 PDI Defatted Soy Flour.

A longer heating time increases protein denaturation and is preferred for making biscuits and crackers. It has a "nutty" flavor and is light brown in color. It is 20 PDI Defatted Soy Flour.

Grinding.

The soy flakes are ground to a flour, using either a hammer mill or a roller, usually with >90% thru a USS 200 mesh sieve. Grits are simply coarsely ground flakes, usually toasted (20 PDI) and are used to increase protein content of breads and impart a nutty flavor, for example as an ingredient in multi-grain bread.

The shelf life of Defatted Soy Flour is one year. The total plate count for soy flour intended for human consumption should be less than 20,000 per gram; typical analyses of flours made under proper sanitary conditions range from 4,000 to 7,000 per gram. Of course tests for E. coli and Salmonella must be negative in a 100 gram sample.

Lecithin may be added to soy flour, typically at 15%. In lecithinated flour the lecithin and the soluble protein are good emulsifiers. This product can partially replace other, more expensive, natural food emulsifying ingredients such as whole egg and milk powder. This results in a large savings of cost for ingredients.

Full fat flour is used as a bread improver for its active enzyme. The main problem is storage instability. While it is easy to make (all that is needed is a source of soybeans and a hammer mill), it is common to find full fat flour with strong beany and rancid flavors and odors. These carry over into the final product. Bakers who have tried to use full fat flour at any significant level (more than 1%, flour basis) are often disappointed with "beany" odors and flavor in the finished bread.

Semi-defatted flour contains 6 - 8% oil. The heat to which it is exposed during processing inactivates enzymes, so it does not have the improving effect of unheated, enzyme active flours. It is reported to have better storage stability during storage than unheated full fat flour. There is little information about its use in bakery applications.

Suggested chemical and biological specifications for defatted soy flour are given in Appendix A.

CHAPTER 3. HEALTH BENEFITS

Soy is a complex mixture of many components. Soy components that have been identified as probable promoters of health include: protein, isoflavones, saponins, phytosterols, fiber, and oligosaccharides. Of these protein is the most important healthy component with respect to bakery products.

Soy flour is a concentrated source of protein. At 50% protein (minimum) it contains nearly five times as much as wheat flour. The addition of soy flour to ordinary bread, at modest levels, significantly increases the protein content of the finished bread. Baked white bread ordinarily contains about 8.2% protein. The addition of 3% (flour basis) defatted soy flour to the dough increases bread protein to 8.8%, and the addition of 5% soy flour raises it to 9.2%.

Addition of soy protein to wheat products enhances the nutritional value of the protein in the finished product. The protein in soy (and other legumes) is deficient in sulfur amino acids (methionine) but relatively rich in lysine. Gluten, on the other hand, is deficient in lysine but rich in cysteine. The combination of the two protein sources creates a better balance of these two essential amino acids. Dietary protein quality is determined as the protein digestibility-corrected amino acid score (PDCAAS). The quality of soy protein is high, approaching that of casein or egg albumen (Table 2). Gluten protein by itself has a low PDCAAS, but the quality of the mixture of soy plus wheat proteins is very high, approaching the score for soy protein alone. If wheat (i.e. bread) is the main source of dietary protein for a person the addition of even modest amounts of soy flour will markedly enhance the healthy aspects of that food.

TABLE 2. SOME PROTEIN QUALITY SCORES

Casein	1.00
Egg albumen	1.00
Soy protein concentrate	0.99
Isolated soy protein	0.92
Toasted soy flour	0.78
Whole wheat	0.42
Wheat gluten	0.25
90% wheat flour + 10% defatted soy flour	0.96

Dietetic foods.

Some people are allergic to wheat gluten and cannot eat regular wheat bread. In response several formulas for "gluten free" bread have been developed. Usually these contain a starch (rice or maize flour), a gum such as carboxymethyl cellulose or carrageenan, and perhaps emulsifiers (monoglycerides, DATEM esters, or a polysorbate). This makes a good bread substitute, usually with a texture more like cake than ordinary bread. Such a 'bread' is almost devoid of protein. Incorporation of 10 to 15% defatted soy flour in the formula provides a moderate amount of protein. The soluble soy protein denatures during baking and gives the finished product a texture resembling regular bread, with better resiliency than the 'bread' lacking soy.

CHAPTER 4. BAKERY APPLICATIONS

Soy flour is commonly used in bread and cake donuts in the United States. Its use by bakers is steadily increasing due to the many advantages of soy protein for the baker and to the consumer. Soy flour has many functions in the bakery: water binding; dough conditioning; emulsification; crust color; and protein supplementation.

Water binding. All soy products bind water. The baker sees this as increased dough or batter absorption (increased product yield). Usually the finished product has increased moisture content, retarding staling and giving longer shelf life. Water binding is a function of the protein and the fiber present in soy flour.

Dough conditioning. Enzyme active soy flour contains lipoxygenase. This enzyme does two things. It bleaches the yellow carotenoid pigments found in wheat flour, giving a whiter crumb. It can interact with gluten during mixing, increasing dough strength. Two items necessary for effective enzyme activity must be present: fat (vegetable oil) and time. The best results are seen when the dough containing enzyme active soy is given a fairly long fermentation time.

Emulsification. Soluble protein is a good emulsifier. However, for additional emulsification bakers use lecithinated soy flour. This combines the wetting action of lecithin with the emulsifying action of protein. Lecithinated soy flour can replace some or all of the expensive ingredients (whole eggs, milk powder) used by bakers for this purpose.

Crust coloration. Soy flour contains about 6% non-fermentable sugars. During baking these take part in the browning reaction of the crust, giving a more pleasing crust color. When baking time is controlled to give a certain desirable color, bake time may be reduced by one or two minutes.

Protein supplementation. This topic has already been discussed in Chapter 3. It contributes to good health for consumers of baked products.

Recommended uses for various soy flours are as follows (DSF is defatted soy flour):

70 PDI DSF: all breads and rolls, cakes, donuts, sweet goods, pasta and noodles

90 PDI DSF: white bread and rolls

20 PDI DSF: biscuits

20 PDI grits: specialty bread, biscuits

Full fat flour: white bread and rolls

Lecithinated flour: cakes, sweet goods, biscuits

Soy Protein Concentrate: high protein specialty bread

White bread and rolls.

70 PDI DSF increases dough absorption by 1 to 1 ½ kg water per kg of soy flour. At 3 to 5% addition the only adjustment usually required is the additional absorption. Higher levels decrease loaf volume (due to the added "weight"). Use of dough strengtheners such as sodium stearoyl lactylate (SSL) or diacetyl tartaric esters of monoglycerides (DATEM) allows addition of up to 12% soy flour with little or no volume loss. Addition of 2 - 3% to sandwich buns improves crumb strength and gives a more pleasing crust color.

Enzyme-active soy flour bleaches crumb color and strengthens gluten. The full-fat type is used at a maximum of 0.5 - 1% on a flour basis; greater amounts often present flavor problems. 90 PDI DSF may be used at any level.

Specialty breads.

DSF, grits, and soy concentrate increase the protein level and nutritional value in high protein breads. At levels of DSF above 5% (flour basis) oxidation is needed to maintain dough strength; 100 ppm of ascorbic acid will provide the needed strengthening.

Soy grits may be incorporated at up to 15% of the dough. Being heavily toasted and with a coarse granulation they require little additional water in the dough. They impart a crunchy texture

and a nutty flavor to the finished loaf. Most multi-grain bread incorporate soy (either flour or grits) in the formula.

Flat breads.

A wide variety of flat breads such as pita bread, arabic bread, balady bread, and chapattis benefit by the addition of 5 - 8% DSF. The finished product has superior flexibility, better strength, more pleasing crust color, and longer shelf life.

Cakes.

Lecithinated soy flour can replace part of the egg or milk in layer cakes (but not sponge cakes) and muffins. The replacement is made on a dry weight basis. Whole eggs are one quarter dry matter, so 4 kg of whole is replaced with 1 kg lecithinated soy flour and about 3 L of water. Whole milk is 12% solids, so the ratio is 1 kg lecithinated soy flour plus 7 L water is equivalent to 8 L of milk in a formula. Dried egg or milk powder is replaced on an equal weight basis.

Donuts.

Addition of 2 - 4% 70 PDI DSF to the batter or dough of a fried product improves water retention and decreases fat absorption during frying. Lecithin is usually included as part of the donut batter (or dry mix). Lecithinated soy flour can be used instead of adding defatted soy flour and lecithin separately, facilitating the production process. The situation with any fried sweet dough product, found in many countries, is the same; by decreasing fat absorption a product with better eating qualities and lower production cost is made.

Sweet goods.

DSF added to layered doughs at a level of 2 - 4% improves both water-holding capacity and sheeting properties of the doughs. Enhanced dough elasticity produces better layer definition during the fat roll-in process and preserves the integrity of the layers during proofing. Expansion during baking is improved, resulting in a flakier, more tender finished product. Overall eating quality is better than in the product without soy flour.

Biscuits (cookies).

The addition of 2 - 3% defatted or lecithinated soy flour to a biscuit dough improves machining properties. For example sheeting of a Marias biscuit dough is easier; the dough sheet is less prone to tear, yet maintains its dimensions at the cutter. The presence of soy flour imparts a crisp,

tender texture to the biscuit.

Lecithinated soy flour can be used as a partial or full substitute for whole eggs in biscuit formulas. The replacement is made on an equal solids basis. For example, 1 kg of liquid whole egg contains 0.25 kg solids and 0.75 L water. Initial trials might substitute 0.25 kg lecithinated soy flour and 0.85 L water. (Experience has shown that slightly more than the equivalent amount of water is needed.) Adjustments to these quantities would then be made to optimize the formula.

Either lecithinated soy flour or 70 PDI soy flour can replace dry milk powder in biscuit formulas on a weight-for-weight basis. This has been successfully tested in several places. High-protein biscuits are sometimes included in specialty diets. Using isolated soy protein biscuits with a protein level as high as 23% can be made. For more modest protein enhancement, substituting a 20 PDI soy flour for 10 - 20% of the wheat flour gives a dough that machines and bakes much like the unmodified formula. At 20% substitution the protein level in the biscuit is doubled. In either case some additional water is added to keep dough consistency at a level to allow good machining on production equipment.

Pasta, noodles.

70 PDI DSF has been successfully incorporated in pasta at 5 - 15% levels. Additional water is necessary in making the paste (to have the necessary consistency for extrusion). Drying the extruded pasta, however, does not present any problems. The finished product is generally identical with the normal pasta.

Soy flour is used to increase the protein quantity and quality in noodles. One manufacturer adds it at 12% to fried (i.e. "ramen") noodles intended for heating in boiling water, and at 20% in fried noodles eaten directly as a snack. In another application, addition of 3% 70 PDI DSF to a Chinese dry noodle formulation gave a more elastic dough with superior processing properties.

CHAPTER 5. PRACTICAL FACTORS

Bakers are, of necessity, practical people, and ask me practical questions:

- Do I have to change the way I operate in the plant?
- What kind of production increase can I actually expect?
- Does soy affect the flavor and odor of my product?
- What product characteristic improvements will I see?

In this chapter these questions will be addressed. The answers given are based on numerous trials using soy flour in a variety of situations. However each bakery is unique, and the only way to prove the applicability of soy flour in a product or production line is to run plant tests. The ultimate proof must be in the hands of a skilled baker.

Practical testing in breads.

The author has made trials using soy flour in 25 countries, in a number of different bakery products, under a variety of conditions. A successful plant trial of defatted soy flour in breads and rolls meets several criteria:

1. Process parameters and machinability are not appreciably changed;
2. Yield increase from additional water absorption meets expectations; and
3. Flavor, odor, crumb color, and volume of the product are acceptable.

When running a trial with soy flour it is very important to have a good control dough for comparison to the test dough. The best situation is where a number of regular doughs are being run and the test can be inserted somewhere in the middle. If the baker is hesitant about interrupting his schedule it may be necessary to make a single dough at a convenient time, to demonstrate that it causes no difficulty for the production personnel, then arrange a second test as part of a regular run.

Process Parameters.

Soy flour should be blended into the wheat flour before it comes in contact with water. If soy flour is added to a partially mixed dough it tends to form small beads and not blend in well with the rest of the dough. Ordinarily mixing time does not change. Occasionally with pan bread a 1 to 2 min. increase in mixing may give better volume and dough strength.

Machinability means primarily that the dough is not too soft or sticky. An experienced mixer will add sufficient water to ensure that the dough is easily divided, rounded, and shaped. Soy flour continues to absorb water for 10 to 15 minutes after full development. A dough that feels slightly sticky at the end of mixing will have the proper feel after a 10 minute rest period before dividing.

Proof time for the bread containing soy flour is the same as for the regular bread. Bake time generally does not change; in a few trials (involving products with a small volume and high surface area) the bake time was decreased slightly to obtain the same crust color as in the control. Dough yield is increased by the addition of soy flour and water. Trials have been made at levels of 2% to 10% of the wheat flour. A reasonable starting point is 3% soy flour (wheat flour basis) plus 5% water. Measuring the amount of water added is important. If the bakery meters water

addition the extra absorption is easily controlled. If water addition is done "by feel" by the mixer, the amounts actually added (to both control and test doughs) should be measured (if possible). Table 3 shows data from a test run in a baking laboratory in Tunisia. Water addition was controlled by an experienced mixer but the amounts were determined by weighing the container of water. The average water/soy ratio is ~1.6.

TABLE 3. WATER UPTAKE BY SOY FLOUR

70 PDI Soy flour, %	0	3	5
Absorption, %	46.4	51.1	54.6
Extra water, %	0	4.7	8.2
Water/soy ratio	--	1.57	1.64

The increase in dough yield is measured by the number of additional loaves obtained. If the dough is divided by hand, the best strategy is to assume that the people doing the dividing are consistent in their scaling and to count the number of pieces in the pans. If a mechanical divider is used, either pan count or a calculated extra yield (extra dough weight divided by average piece cut weight) is sufficient.

Decreased bake loss can generate more profit for the bakery if the dough dividing equipment is well controlled. One percent less bake loss means that the baker can decrease dough cut weight by 1% and still have the same finished weight of product to sell. While this may not seem like much, to a baker a 1% increase in the number of loaves per dough is significant. To achieve this result dough cut weights must be carefully monitored and controlled. In numerous trials involving pan breads, baguettes, batons, and arabic breads the decrease in bake loss is almost without exception in the 2 - 3% range.

Product Characteristics.

Using good quality defatted soy flour, no "beany" odor or taste in the product will be observed. Crumb color may vary slightly from that of the control, but should be within acceptable limits. Volume may decrease slightly at higher levels of soy flour. This is most obvious with some pan breads, but is not usually noticeable with other types such as baguettes or arabic bread.

Shelf life of the control and the test product should be evaluated for several days after baking. Soy flour increases moisture retention (decreases bake loss) in the finished product. This results in a longer shelf life (less staling) for the product. As a rule of thumb, increasing bread moisture by 1% increases shelf life by one day.

In many countries bread flour is not bleached at the mill. As discussed above, enzyme active soy flour can bleach the carotenoid pigments of flour, giving a whiter crumb. Enzyme active soy flour, with its gluten strengthening effect, sometimes shows a small volume increase. More important can be an improvement in the grain of the crumb. Other product quality factors should also be noted. Some that have been seen from time to time are: increased flexibility of arabic bread; better sidewall (crust) color of pan bread; improved shape in croissants, with less "flyaway" at the center point; pleasing "nutty" flavor note in toasted sliced bread; and enhanced crumb resilience in hamburger (sandwich) buns.

Practical testing in cakes and biscuits.

Both 70 PDI and lecithinated soy flour find application in these bakery products. Dry milk powder can be replaced with an equal weight of 70 PDI soy flour, with additional water needed to keep the batter or dough consistency the same as that of the unaltered formula. A more usual approach in a shop producing cakes or muffins is to replace the whole egg (partially or completely) with 15% lecithinated soy flour. Whole egg is about one-fourth dry matter; for an initial trial four parts whole egg is may be replaced with one part lecithinated soy flour and three parts water. It may be necessary to adjust the amount of water used to obtain a batter consistency that is the same as in the control. The economic advantage in making this substitution is examined in the next chapter.

In biscuits either lecithinated soy flour or 20 PDI defatted soy flour may be used. In many countries non-governmental organizations (NGOs) want to include biscuits as part of their feeding program for school children. Part of the specification is an elevated protein content, typically 12% protein in the finished biscuit. To obtain this protein level soy flour is necessary. Whenever additional protein is needed in a bakery item a soy flour product is the most cost-effective way to deliver it.

Tests in noodles and pasta.

Defatted soy flour can be used in noodle and pasta formulations. A simple formulation adds 3% 70 PDI soy flour plus 5% water to a base noodle dough. The resulting dough sheet was more elastic than the base dough, and the cut noodle strands were easier to handle on the way to the drying chamber. In tests of pasta (spaghetti) 10% of the semolina was replaced with an equal weight of 70 PDI soy flour. After adjusting the water content to get correct properties for extrusion the run was normal. The cooking and eating qualities of the dried spaghetti was judged equal to or better than the control.

CHAPTER 6. ECONOMIC FACTORS

When presented with a new ingredient the baker asks "How much does it cost?". The surprising answer is that by using soy flour the baker actually increases his profits!

Economics in the bakery.

A baker can quickly look at the profit/loss picture using his production and sales numbers. Assuming the basic bread dough is based on 50 kg wheat flour, the baker would add 1.5 kg defatted soy flour and 2.5 L water, to make 5 kg of extra dough. How many extra loaves of bread does this represent, and what is the income from selling that bread? As an example, I will use data from an Istanbul bakery in January of 2005 (NTL is the New Turkish Lira, equal to about \$1.25 US). The same analysis has been made in many countries with essentially the same result: Soy flour cost 0.80 NTL per kg;
Bread sold for 0.25 NTL per loaf;
1.5 kg soy flour + 2.5 L water yielded 4 kg of dough;
4 kg of dough made 16 loaves of bread (250 g cut weight);
16 loaves of bread sold for 4.00 NTL;
1.5 kg of soy flour cost 1.20 NTL;
Bakery profit was increased by 2.80 NTL.

A more exact calculation of costs and profits, plus the ability to explore the effect of changes in prices, can be done with a simple spreadsheet. The one shown in Table 4 is based on data from Nigeria in April 2008. The fourth column summarizes costs and yields for a control dough, while the sixth column does the same for a dough with 3% soy flour and 5% extra water. The "Margin" is simply total sales minus ingredient costs. While not the same as actual bakery profits the extra "margin" (Table 4A) should largely translate into extra profit.

Table 4. BREAD COST ANALYSIS

Ingredient	N/kg	Control		With 3% Soy	
		kg/dough	N/dough	kg/dough	N/dough
Wheat flour	116	100	11600	100	11600
Salt	40	2	80	2	80
Yeast	600	2	1200	2	1200
Aditive	700	0.5	350	0.5	350
Soy Flour	150	0	0	3	450
Water	0	60	0	65	0
Totals		164.5	13230	172.5	13680
Dough cost, N/kg			80.43		79.30
Cut weight, grams		930		930	
Loaves/dough		176.9		185.5	
Price/loaf, N 300					
Sales/dough, N		53065		55645	
"Margin", N		39835		41965	

Table 4A. PROFIT SUMMARY

Extra loaves 8.9
Extra sales, N 2581
Soy cost, N 450

Extra "margin", N 2131

The analysis to use depends on the size of the bakery. A smaller baker will typically produce a certain number of doughs per day, selling all the bread that is made. In this case the "simple" analysis gives a good picture of potential profits. A large wholesale baker will make a certain number of loaves of bread per day to service his retail customers. For this type of operation the "precise" analysis is more appropriate. The baker should set up a spreadsheet such as that shown above, using his ingredient costs, cut weights, and selling price, to evaluate the profits available to him. I have done this in many countries; almost without exception the numbers are favorable.

Whole egg and milk powder replacement.

Another way in which bakeries can reduce ingredient costs is by replacing whole egg or dry milk with lecithinated soy flour. As mentioned earlier this may be either partial or complete replacement, depending on the results of testing. The economics are more complicated due to large variations in the local price of these ingredients. The current price of 15% lecithinated soy flour in the United States is about \$0.75/kg. Delivered overseas the price should not be more than \$1.50 (local equivalent). The baker should compare this to the local price of 4 kg of whole egg or 1 kg milk powder (or 8 kg liquid milk) to see how much could be saved.

Dry milk powder (and dry whole egg, if that is being used) can be replaced with an equal weight of lecithinated soy flour. In the U.S. the cost is cut in half. If the local price of lecithinated soy flour is in the range of \$1.50/kg then the cost saving is again obvious.

Conclusions.

- 1) The use of soy flour in the bakery increases profitability for the baker. Water absorption by soy flour plus retention of moisture during baking (decreased bake loss) results in a greater yield that translates into increased product sales. These more than compensate for the cost of the soy flour.
- 2) The addition of soy protein (e.g. 70 PDI defatted soy flour) to wheat flour in bakery applications enhances the protein content and the amino acid balance in the food. This provides a more nutritious product, particularly for consumers for whom bread is the main source of dietary protein.
- 3) In bakery products soy flour absorbs water and retains this moisture, extending the shelf life and decreasing the staling rate of the product.
- 4) In general the addition of soy flour to a dough or batter requires few adjustments in bakery processing operations.
- 5) Partial or full replacement of liquid whole egg and/or dry milk powder in certain confectionery bakery products yields a significant saving in ingredient costs.
- 6) The finished product is usually indistinguishable from that of the product without soy flour. In certain instances quality is improved.
- 7) The baker profits and the consumer benefits -- a winning situation for everyone.

APPENDIX A. TYPICAL SPECIFICATION FOR DEFATTED SOY FLOUR

Chemical and physical

Moisture	8% maximum
Protein (as is)	50% minimum
Fat	1% maximum
Color	White to pale cream
Odor	None
Taste	None to faint beany note

Microbiological

Total Plate Count	20,000/gram maximum
Total Coliforms	100/10 grams maximum
E. Coli	Negative/100 grams
Salmonella	Negative/100 grams
Staphylococcus	100/10 grams