

# Soybean Food Wrapper

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## Statement of Problem & Background:

Burger and sandwiches are consumed in enormous amount daily in the U.S. However, eating burger or sandwich is usually pretty messy. Most burgers and sandwiches cannot hold themselves together when being eaten. Currently, there is no well developed edible food wrapper on the market to help people eat burger or sandwich without falling apart. We are developing a brand new product to solve this problem, the edible Soybean Food Wrapper. Study showed soy protein has good film forming abilities and excellent barrier properties against oxygen and oil movement in low relative humidity

## Global & Social Impact:

The use of natural renewable resources soybean for creating new industrial products is a critical factor for future economic growth, given dwindling resources and increase emphasis on industrial environmental stewardship. With soybean film wrapper, there will be less using of napkins to clean up after having fast food and less using of wrapping paper. It also expands the type of food people can eat on their way to work or study to help them being healthy and saving time.

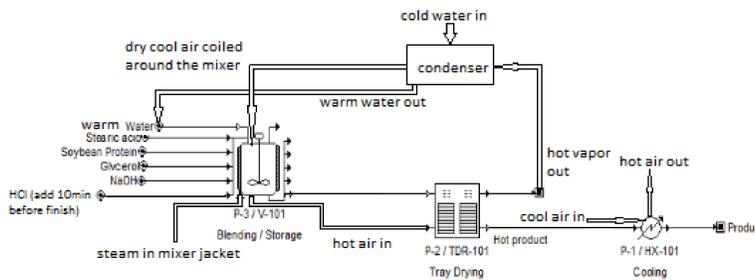
## Literature Review & Patent Search:

Edible soy protein wrapper is under the international classification: A23, C08. The searches were done by key word search, citation and relevant patent checking under same classifications.

Although 17 patents were found by Espacenet Patent Search using key words (soy, protein, edible, film), only 2 patent were considered relevant to our product idea (CN101715870 B and CN 101550275 A). Both of these two patents are produce edible films by soy protein isolate with xylan or collagen, glycerol, and extrusion process were needed for the film product. The major application of these twokinds of films is for raw meat product and sausage, which is totally different form our product idea. By looking for the citation and patent citing these patents, no relevant patent were found.

Burger and sandwiches are consumed in huge amount every day in the US. However, all burgers produced on the market cannot hold themselves together when people eat them. Related edible package film is not well developed to help people with eating burgers or sandwiches without falling apart. Soy protein has been studied for its good film forming abilities and excellent barrier properties against oxygen and oil movement in low relative humidity (Gennadios, McHugh, Weller, & Krochta, 1994). Most soy proteins (~90%) are globulins, which can be fractionated into 2S, 7S, 11S and 15S according to their sedimentation coefficients. The major soybean proteins have molecular weights ranging from 200 to 600 kDa. The 7S and 11S fraction, the main fractions making up about 37% and 31% of the total extractable protein, have the capability of polymerization (Wolf, 1972). The formation of the films from soy proteins has been described as a two-step process involving the heat denaturation of the proteins followed by surface dehydration.

## Design and Formulation:



### Design Specs

Unit equipment	Equipment size	Power usage	Cost (\$)
Mixer	0.3 m <sup>3</sup>	8 kW	2000
Tray Dryer	450 m <sup>2</sup>	20 kW	600000
Condenser	15 kg/h	1 kW	5000

## Budget Information & Timeline:

Equipment cost	
Equipment	price (\$)
Mixer	2000
Tray dryer	600000
Direct-contact condenser	5000
<b>Total</b>	<b>607000</b>

Estimation of total investment cost	
Direct cost	cost (\$)
Equipment	607000
Installation	236730
Instruments and control	157820
Piping	188170
Electrical system	60700
<b>Total</b>	<b>1250420</b>
Indirect cost	
Engineering and supervision	194240
Construction	206380
Legal expenses	24280
Contractor's fee	115330
Contingency	224590
<b>Total</b>	<b>764820</b>
Working capital	302286
<b>TCI</b>	<b>2317526</b>

Estimation of total production cost (per year)	
Direct production	cost (\$)
Raw material	262800
Operational labor	90000
Direct supervisory and electric labor	120000
Utilities	90000
Maintenance	40000
Operating supplies	4000
Laboratory charges	9000
Patent and royalties	12000
Plant overhead cost	80000
General expenses	
Administration	45000
Distribution and selling	50000
Research and development	10000
<b>TPC</b>	<b>812800</b>

## Material & Energy Balance:

### Material balance:

Overall Balance(kg/Batch)					
COMPONENT	INITIAL	INPUT	OUTPUT	FINAL	OUT-IN
Glycerol	0.00	10.00	10.00	0.00	0.00
HCl	0.00	5.00	0.00	5.00	0.00
air	0.27	100.00	0.00	100.27	0.00
Oxygen	0.08	0.00	0.00	0.08	0.00
Sodium Hydroxide	0.00	5.00	5.00	0.00	0.00
Soybean Protein	0.00	20.00	20.00	0.00	0.00
Stearic Acid	0.00	20.00	20.00	0.00	0.00
Water	0.00	100.00	0.00	0.00	100.00
<b>TOTAL</b>	<b>0.36</b>	<b>260.00</b>	<b>55.00</b>	<b>105.36</b>	<b>100</b>

### Energy balance:

$$0 = Q \text{ (electricity)} + Q \text{ (heating)} - Q \text{ (cooling)} - Q \text{ (heat loss)} - Q \text{ (evaporation)}$$

$$0 = 3324.24 \text{ kJ/s} + 1.23 \text{ kJ/s} - 3316.87 \text{ kJ/s} - 8.6 \text{ kJ/s}$$

## Economics:

Financial summary	
	Number of units
Yearly production (unit area)	7884000
Sales price per unit (\$)	0.15
Total income (\$)	1182600
Gross income (\$)	369800
Tax	35%
Net profit (\$)	240370
ROI (%)	45.5

With a ROI of 45%, the factory is very profitable if initial investment is not considered. With consideration of initial investment, the breakeven rate of interest is about 2.6%.

## Alternative Solutions and Evaluation:

### Mixing

Mixer with different shapes and sizes may gives better mixing efficiency. Many types of agitators exist for mixing, such as four-blade paddle, gate or anchor paddle, six-blade open turbine

### Drying

Drum dryer: better for flake or powder form of product instead of sheet form.

### Condensing

Surface condenser: uses much more energy and cooling water, causes more maintenance cost

## Future Work:

The product needs to be tested with different machines for different desired properties, like digestible, water resistant, heat resistant and tensile strength. In order to make the best soy film product for our applications like burger or sandwich wrapper, different combinations of the ingredients should be tested. To approach the best process for producing the product with good quality and being economically feasible, different methods and instruments should be compared.

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