

Soybean Milk Production

by

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大豆乳生産

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要 約

Soybean milk(大豆乳)는 지난 數千年間 主로 東洋에서 貴重한 食品으로서 때로는 牛乳의 代用品으로서 계속 使用되어왔다. 이의 原料인 大豆의 種類는 數百種이지만 其中에서 가장 代表的인 것은 黃皮大豆, 黑皮大豆 및 綠皮大豆이다. 그러나 이것은 外皮의 色素의 差異에서 區別될 뿐이고 cotyledon의 性狀 및 化學的 成分은 거의 비슷하고 學名 *Glycine max* Merryl로서 一括하여 불리워진다.

大豆乳는 大豆의 蛋白質·脂肪分 및 炭水化合物이 물에 懸濁되어서 생긴 emulsion이고 消化성이 좋고 榮養分이 豊富함은 우리 祖上時代부터 이미 認識되어왔다.

그러나 大豆의 產地 및 種類가 다를 때의 比較에 對하여, 卽 印度產 黑皮大豆와 韓國產 黃皮大豆 사이의 水浸出性, 風味檢査 및 生産比率 等の 比較檢査에 關한 報告를 찾아볼 수 없다. 또한 여러 가지 條件下에서의 熱處理 및 殺菌加熱 等이 收率 및 風味에 미치는 影響에 關한 報告가 없었으므로 著者는 이 問題를 究明하려고 이에 關한 實驗을 하였다. 또한 榮養價와 嗜好性을 增加시키기 爲해 安全한 食品添加劑 添加를 試圖하였다. 끝으로 連續의 大豆乳生産工場의 보기를 紹介하였다.

Abstract

The utilization of soybean milk has lasted for past several thousand years, mostly in Orient as a precious food⁽¹⁾⁽²⁾ or as a substitute⁽³⁾ for cow's milk.

There are several hundred varieties⁽⁴⁾ in soybean that is called *Glycine max* Merryl⁽⁵⁾. There are three typical varieties, Yellow, Black and Green. However, these are due to pigment in soybean cuticle while their chemical constituents⁽⁶⁾⁽⁷⁾ are similar (Table 2).

Soybean milk⁽⁸⁾⁽⁹⁾⁽¹⁰⁾⁽¹¹⁾ is constituted of protein, fat and carbohydrate of soybean, and these constituents are extracted by hot water. Thus becomes emulsion which is highly digestible and nutritious for human diet.

However, it was not found any report on the water extractability comparison between two different varieties: Black cuticle soybean which is common in India and Yellow cuticle soybean which is common in Korea. Also there was no report on the comparison on the yield and organoleptic quality derived by varied process.

Also several attempts were carried out to improve nutritional value as well as acceptability by use of food additives. A model of continuous soybean milk plant⁽¹²⁾ was introduced.

1. Introduction

In many regions of the Middle and Far East Asia, and Africa, there are much scarcity of milk. In India, statistics show that availability of milk is only 140ml/person/day.⁽¹³⁾ Considerable work has been carried out on the use of oilseed, like groundnut and legumes, like soybean for the preparations of milk like emulsions for the consumption by the people as a substitute for milk. Soymilk is now being marketed in Hong Kong, under the trade name of VIT-ASOY,⁽¹⁴⁾ and a similar product is popular in Thai-

Table 1. Composition of UNICEF Powder

Moisture	4.0%
Protein	41.0
Fat	22.0
Carbohydrate	22.3
Fibre	5.3
Ash	5.4
Water soluble protein	40.0%
Amino acid	5.0
Non proteinous nitrogen	1.0
PH	6.2

Table 2. Chemical composition of various soybean(%)

Place of produce	Moisture	Protein	Fat	Soluble Carbohydrate	Fibre	Ash
America	7.74	35.00	20.37	26.57	4.50	5.79
Europe	9.94	34.30	17.69	28.44	4.79	5.31
Japan	10.00	33.20	17.50	30.20	4.40	4.70
Korea	12.00	37.12	18.69	22.88	4.60	4.22
Manchuria	8.89	39.27	17.24	28.78	4.55	5.83

2. Experiment

2. 1 Raw materials

land. Also UNICEF Powder⁽⁷⁾⁽¹⁵⁾ the composition of which is shown in Table 1 is being utilized in developing countries.

In India, work on the use of groundnut to prepare groundnut milk has been in progress for a number of years. Though the process has been standardised, it is felt that odor of groundnut is offensive in this milk, and hence it is now being used only for making curds that is sometimes called Yoghurt.

Recently a new product based on the use of the protein isolate from groundnut has been standardised. In this process the emulsion of the groundnut protein isolate blended with glucose syrup is mixed with an equal part of cow or buffalo milk. The product is called Lac-Tone⁽¹⁶⁾⁽¹⁷⁾ or Toned milk⁽¹⁶⁾⁽¹⁷⁾ in India. The nutritive value of these vegetable milk have been tested by several research workers and have been generally shown to be acceptable for child feeding.⁽¹⁸⁾

Soybean has been selected as it is a raw material available in Korea in large quantities. The variety of the soybean has a very important effect on quality of the processed milk. Also it was found that the processing method greatly affects on the soybean milk quality. Chemical compositions are shown in Table 2.

Three common varieties are Yellow, Black and Green. Yellow soybean of Korea and Black soybean of

India were selected due to their availability in each country. Yellow soybean was produced in Kangwon, Korea while Black soybean was produced in Bengal, India.

2. 2 Procedures

400 gm each of the varieties were taken and soaked in water for 18 hrs at room temp. The soaking water was changed once in 6 hrs to avoid the danger of putrefaction and to remove the bitter component. The soaked soybeans were taken out and the cuticle was removed by gentle rubbing.

Each of the lot was divided into four equal parts and the following flow sheet was applied:

(a) Preliminary preparation→Autoclaving at 15 psi for 15min.→Cooling→Grinding for 5min. with 500ml water→Filtration with cloth.

(b) Preliminary preparation→Grinding for 5 min. with 500ml water→Autoclaving at 15psi for 15min.→Cooling→Filtration with cloth.

(c) Preliminary preparation→Grinding for 5 min.

with 500ml water→Filtration with cloth→Autoclaving at 15psi for 15min.

(d) Preliminary preparation→Grinding for 5min. with 500ml water→Heating at 100°C for 5min.→Filtration with cloth:

Finally, each of these (a),(b),(c),(d) were bottled and sterilized⁽¹⁹⁾ at 15psi for 15min.

2. 3 Organoleptic test

Bottled soybean milk was distributed to 20 research workers out of which 10 were nationality of India and the other 10 were from different countries of South East Asia. According to result, soybean milk prepared by (d) method was the most acceptable thus sample (a), (b), (c) was omitted from the test. Cow's milk served as control.

3. Result

3. 1 Experimental result

Result of the soybean milk is shown in following Table 3.

Table 3. Result of experiment on soybean milk

Variety of Soybean	Method of Treatment	Soybean milk obtained from 100 gr of Soybean			
		Volume	Colour	Flavour	Stability
Black cuticle (India)	(a) Autoclaving soaked bean, later ground and filtered See procedure	280 ml	Brownish Gray	Overcooked-flavour Soybean-pulse like flavour Unacceptable	*Poor Waterly Precipitated
-do-	(b) Autoclaving after grinding without filtration See procedure	320 ml	Grayish White	Soybean-pulse like flavour Acceptable	*Good
-do-	(c) Autoclaving after filtration See procedure	300 ml	Whitish Gray	Soybean-pulse like flavour Slightly acceptable	*Poor
-do-	(d) With heat treatment before filtration Finally autoclaved See procedure	350 ml	Slightly grayish than cow's milk	Soymilk like flavour Very acceptable	*Good
Yellow cuticle (Korea)	(a) See procedure	230 ml	Brownish	Over cooked-flavour Soybean like flavour Unacceptable	*Poorest Waterly Precipitated
-do-	(b) See procedure	400 ml	As white as cow's milk.	Soymilk like flavour Very acceptable	*Good
-do-	(c) See procedure	340 ml	Slightly grayish	Acceptable	*Fair

-do-	(d) See procedure	470 ml	As white as cow's milk	Soy milk like flavour Highly acceptable	*Excellent
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*Remarks: The order of stability is Excellent > Good > Fair > Poor > Poorer:

3. 2 Organoleptic test

Organoleptic evaluation of Soybean milk is shown in following Table 4.

Table 4. Organoleptic scores of soybean milk

Native place of panels	Control samples		Test samples
	Cow's milk	Yellow cuticle Korean soybean	Black cuticle Indian soybean
South-East Asia	*10	8	6
India	10	7	5

*Remark: 10 is the highest score
1 is the lowest score

3. 3 Enrichment of Soybean milk

1) **Cow's milk:** This is the surest method to improve Soybean milk quality in every respect. In economical view point, less than 50% of cow's milk should be mixed. However, the better quality was obtained by higher percentage of cow's milk.

2) **Flavouring agents:** This was used along with or without colouring agent. It was found very effective to improve acceptability. The flavours used are as follow:

- | | |
|--------------------------|-------------------------|
| i. Malt extract | vii. Strawberry essence |
| ii. Coffee | viii. Banana essence |
| iii. Cocoa | ix. Pineapple essence |
| iv. Butterscotch essence | x. Mixed fruits essence |
| v. Icecream soda essence | xi. Orange essence |
| vi. Vanilla essence | xii. Lemon essence |

3) **Colouring agents:** It was found less effective than that of flavouring agents. However, it has improved acceptability by appearance. The colouring agents used are as follow:

- i. Rose pink (specially in India)
- ii. Orange yellow
- iii. Caramel
- iv. Chocolate

4) **Stabilizing agents:** To prevent sedimentation of soybean milk, buffer salt of phosphates or citrates, emulsifiers like alginates, mono, di-glycerides or

C.M.C. were used. These are added before sterilization, and it was found satisfactory.

5) **Vitamins and minerals:** These are to be added for nutritional value improvement. Examples are shown in Table 5.

Table 5. Composition of *toned milk

Composition	Values per 100 gm
Total solids	11.7 gm
Fat	2.5
SNF	9.2
Protein	3.5 (1.7 from cow's milk and 1.8 from vegetable milk)
Lactose	2.4
Glucose or Malti- dextrins	2.4
Vitamins added	
Vitamin A	1,500 I. U.
Vitamin D	40
Vitamin C	3.0 mg
Vitamin E	0.2
Thiamine	0.06
Rivoflavin	0.10
Pyridoxine	0.03
Niacinamide	0.60
Calcium Pantothenate	0.38
Vitamin B ₁₂	0.22 µg

*Toned milk Cow's milk mixed with vegetable milk

4. Conclusion

4. 1 **Influence of Soybean variety:** The colour of the milk which is prepared from Black cuticle variety is not suitable for preparation of Soybean milk due to dark pigment extraction from its black cuticle. Yellow cuticle variety of Korea was most suitable due to its pleasant colour, high yield, flavour acceptability and excellent stability.

4. 2 **Influence of autoclaving method:** The yield of milk, when soybean was autoclaved before grinding, was the lowest and its organoleptic quality was also very poor. The best method was (d) where the paste was heated to boiling for 5 minutes. This

method showed highest extraction as well as excellent quality.

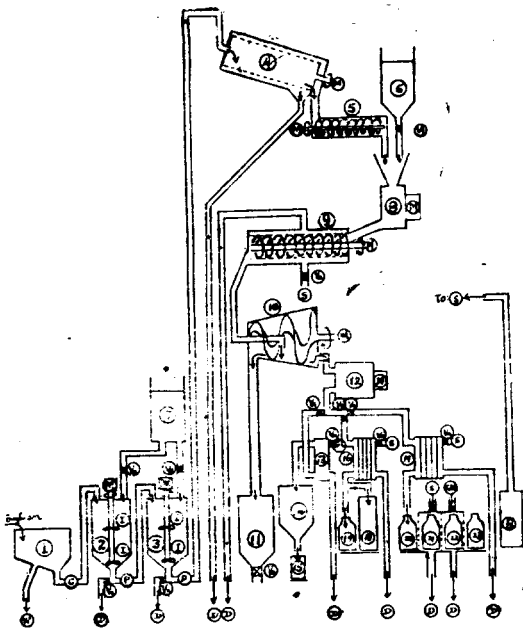


Fig. 1. Model Soybean milk plant

Table 6. Legend of Fig. 1.

C:	Variable capacity conveyor
P:	Variable capacity pump
M:	Variable RPM motor
V1:	Variable flow valve
V2:	Manual valve
VA:	Manual valve for spray dryer
VB:	Manual valve for pasteurized soybean milk
VC:	Manual valve for sterilized soybean milk
B:	Boiler
CW:	Cold water
S:	Steam inlet
W:	Waste outlet
D:	Drain
I:	Impeller
1:	Soybean cleaner
2:	Washing tank
3:	Soaking tank
4:	Rotary drainer
5:	Feed regulator
6:	Water tank

7: Water tank(7 can be eliminated when piping is connected to 6)

8: Grinder

9: Continuous cooker

10: Horizontal continuous decanter

11: Residue holding bin for cattle feed purpose

12: Homogenizer

13: Film evaporator

14: Spray dryer

15: Gas packaged spray dried soybean milk

16: Pasteurizer

17: Bottled pasteurized soybean milk

18: Bulk container for wholesale soybean milk, soybean curd (TOFU) and/or cheese production

19: Preheater cum exhauster

20: Bottling for sterilized soybean milk

21: Sterilizer

22: Cooler

23: Sterilized soybean milk

4. 3 Influence of additives: Sweetening and flavour additives are the most effective method to improve the quality of soybean milk. However, colouring agents are not primarily influencing factor. Thickening agents or protective colloid are recommended to be added for the retention of emulsion characteristics.

4. 4 Influence of cow's milk: It was clearly found that mixing of cow's milk into soybean milk can greatly improve the quality and acceptability as milk substitute. Especially this was approved by the soybean milk cheese processing.

4. 5 Prospective processing of Soybean milk: Soybean milk should be processed into evaporated, condensed or spray dried forms for easy handling, longer storage life, emergency, defence or famine relief of developing countries.

4. 6 Prospective utilization of Soybean milk: It is widely known that it is one of the protein rich fluid foods as it is or as substitute for cow's milk. However, future outlet for soybean milk is to be utilized as intermediate material for the production of soybean curd and soybean milk cheese.

4. 7 Model soybean milk plant layout: Soybean milk can be prepared in domestic scale with tra-

ditional method. However, a model plant is designed⁽¹²⁾ as shown in Fig. 1., Table 6., with compactness, efficient performance, minimum chance of contamination, minimum number of operator. The capacity of this plant may process 50kg/hr to 500kg/hr of raw material soybean continuously.

4. 8 Economic status of soybean milk: Price ratio comparison of soybean milk against several protein foods is shown in Table 7. It shows that soybean milk cost is only 29% of pasteurized cow's milk.

Table 7. Price index of protein foods in Korea, May 1969.

Roasted soybean powder	*1
Soybean milk	1.3
Freeze dried soybean curd(Tofu)	1.5
Chongkuk-Jang(Natto)	1.6
Soy sauce	1.7
Fermented Soybean mash(Miso)	1.9
Egg	3.5
Whole milk powder	4
Pasteurized milk	4.5
Pork	5
Beef	9
Sausage	10

*Roasted soybean powder served as standard.
Price ratio is based on dry weight of protein.

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