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Quality Improvement of Korea Traditional *Nuruk*

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1. Introduction

Korea traditional rice wine (*Yakju* and *Takju*) is produced from various cereal (rice, wheat) and Nuruk, which contains enzyme and yeast concerning alcoholic fermentation. *Nuruk* production comprises several steps as following; grinding raw wheat, adding water (20%), molding and fermentation at 30℃ for 15 days. Major micro-organisms proliferated during Nuruk fermentation are *Aspergillus sp.*, *Rhizopus sp.*, *Absidia*, wilde yeast, and lactic acid bacteria. In rice wine fermentation, *Nuruk* works to supply the source of enzyme saccharifying starch like Koji as well as of mother yeast.

The source of saccharification enzyme used in brewery of Yakju and Takju is Koji, in which inoculated by *Aspergillus shirousamii* and *Aspergillus kawachii*. Rice wines produced with this method therefore have the taste and flavor like Sake rather than traditional Yakju. In addition, many researcher and producer concerning on traditional brewing have suggested important technical problems to develop the brewing industry such as describing below.

- Difficulty in self-production of Nuruk
  - Changes in quality due to environmental condition and high cost for production and labor
  - Reducing of characteristic of their own by using Nuruk on the market
  - Low quality of final product
- Insufficiency of fermentation technique
  - Difficulty of quality control because of a lack of scientific data
  - Rapid acidification and degradation by using of low quality Nuruk
  - Difficulty of technical advice for quality improvement
- Production cost
  - High cost of raw material and packing charage
  - Higher price than other alcoholic beverage

In our group, in order to revive korea traditional alcoholic beverage, many researches have continued for longtime. Particularly, the result on development of Nuruk manufacture and enzyme activity could achieve

the large-scale production of Nuruk, the improvement of brewing method and the production of uniform quality. Therefore, in this presentation, the results concerning quality-improved Nuruk will be showed in this presentation

2. The present state of traditional Nuruk

2-1. Properties of traditional Nuruk on the market

Traditional Nuruks have various form, size and weight according to production region (Table 1). Circle and square was general form for the production of traditional Nuruk. The type and number of microorganism is also different with the origin that Nuruk was produced (Table 2). The microorganism consisted mainly of bacteria and mold. Saccharogenic power, that is indicated the ability of transfer from starch to monomer, did not relate with the number of microorganism. Moreover, the saccharogenic power of all traditional Nuruk was lower than 500. It is therefore shown that in order to improve the quality of Nuruk, the microorganisms possessed powerful enzyme activity firstly have to be identified and purified, and thus these results apply to the manufacture process of Nuruk.

Table. 1 Shape of traditional Nuruk

Shape	Size (cm)	Weight (g)	Origin
Circle	38×2.0	1,515	Jinju
	14×2.0	272	Deagu
	16×5.5	790	Cheolwon
	20×5.0	432	Sangju
Square	16~17×3~3.5	800~860	Hyeunpoong Goryung
Shapelessness		163	

Table. 2 Microorganism and saccharogenic Power (SP) of traditional Nuruk

Origin	Mold (×105/g)	Yeast (×105/g)	Bacteria (×105/g)	DU (units/g)	SP (units/g)
Pochun	3,600	18	24,300	800	480
Jinju	662	-	5,400	1,220	86
Sangju	1,500	-	150	402	90
Hyeunpoong	513	-	459	1,275	450
Goryung	63	-	144	1,255	150

2-2. Microbial species in traditional Nuruk

A number of species existed in traditional Nuruk were reported (Table 3). Main specie of each microorganism was found such as that mold was *Aspergillus sp.* and *Rhizopus sp.*, yeast was *Saccharomycess sp.* and Bacteria was *Bacillus sp.* Various species of each microorganism have an influence on alcohol production as well as formation of flavor and taste during fermentation. These researches could

supply important information for selecting species to apply on manufacture of improved Nuruk. On the base of the results of saccharogenic power, 2 species of *Aspergillus sp.* and 1 specie of *Rhizopus sp.* were used for improved Nuruk.

Table. 3 Microbial species found in traditional Nuruk

Microorganism	Species
Mold	*Aspergillus sp., Rhizopus sp., Amylomyces sp., Monascus sp., Penicillium sp., Mucor sp., Absidia sp.*
Yeast	*Saccharomyces sp., Saccharomycopsis fibuliger, Torula sp., Torulopsis, Rhodotorula minuta, Mycoderma sp., Willia sp., Monilia sp., Sachsia sp., Endomyces sp., Oidium sp., Candida sp., Hansenula sp., Pichia delftensis, Sachwanniomyces occidentalis*
Bacteria	*Bacillus sp., Lactobacillus sp., Leuconostoc mesenteroides, Micrococuss sp., Pseudomonas sp., Pediococcus sp., Mycoplana bullate, Erwinia sp., Aerobater cloacea, Butyic acid bacteria, Alcohol fermented bacteria*

3. Manufacture of quality-improved Nuruk

Fig. 1 shows the changes in moisture content and saccharogenic power of Nuruk during fermentation. At 34 hour incubation, saccharogenic power was increased to 902 sp and the formation of hypha was begun. The gradual increase of saccharogenic power and the formation of Nuruk flavor was found after 48 hour. When incubation was finished (96 hour), the improved Nuruk having small spore and high sacchrogenic power (1350 sp) was produced. Moisture content was slowly decreased and final value was approximately maintained at 20%.

From various results concerning with improved-Nuruk production, we suggested the most useful manufacture process in Fig. 2. Such improved-Nuruk could confer some benefits for traditional brewing

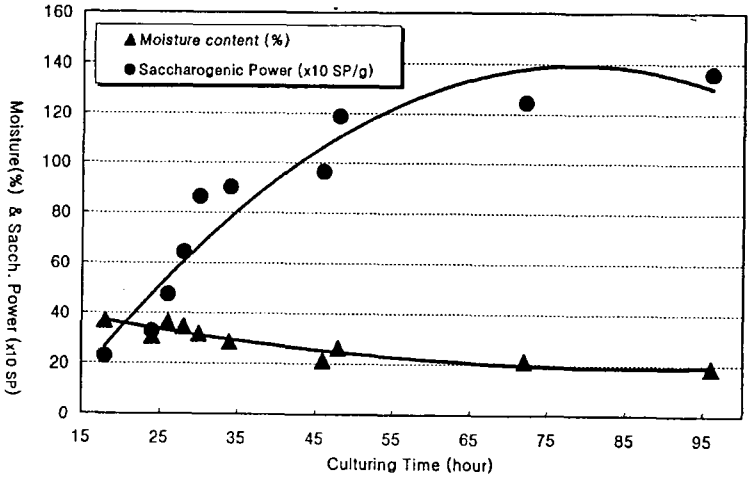

Fig. 1 Change of saccharogenic power and moisture content during an improved Nuruk culturing

industry. First, since saccharogenic power was 3 times higher than that of traditional Nuruk, alcoholic fermentation was quickly processed and high alcohol production was obtained. In addition, it is convenient to storage and usage because of noodle-type shape, and same quality of alcoholic beverage could be produced.

In next step, in order to verify the effect of improved Nuruk, it was used for making various type of traditional alcoholic beverage.

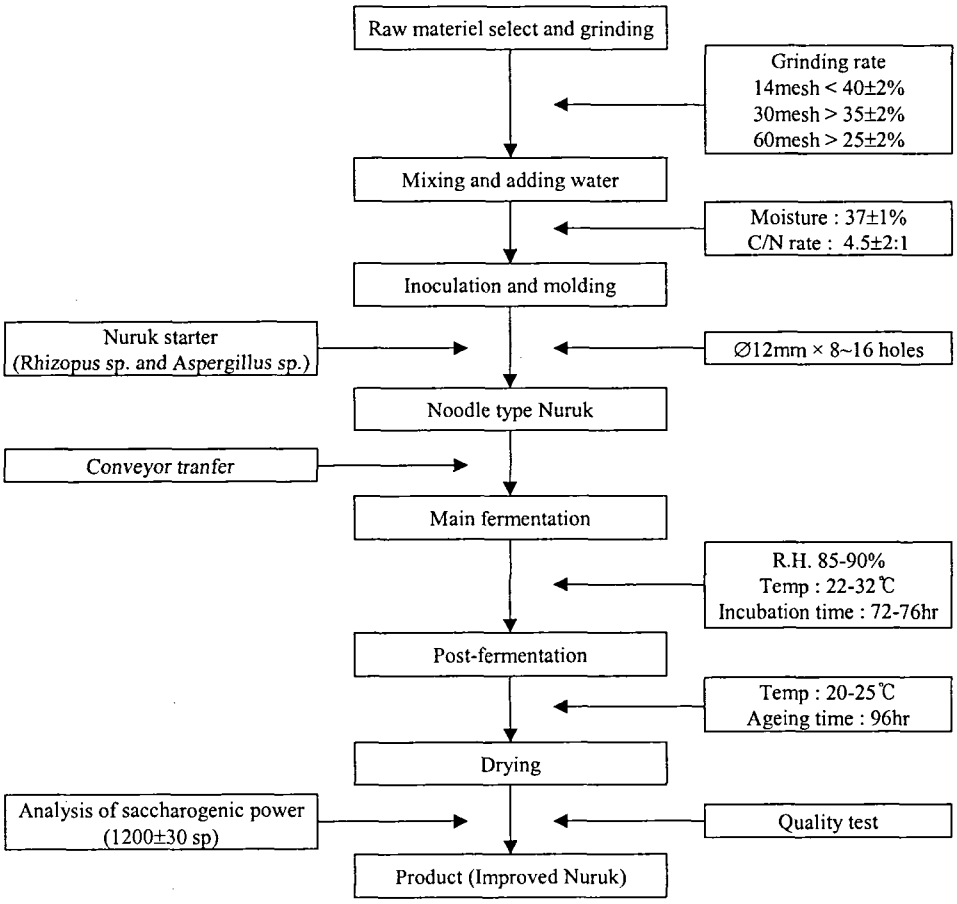

Fig. 2 Manufacturing process of improved Nuruk

4. Properties of rice wine using improved Nuruk

The properties (free sugar, organic acid, amino acid and volatile compounds), which are concerned with taste and flavor of alcoholic beverage, was measured (Table 4), when improved Nuruk was used for alcohol fermentation. Significant increase in total amount of free sugar, organic acid, amino acid and volatile compounds were found in mash used improved Nuruk. This fact may be justified, probably, by the effect of high sacchargenic power and enzyme activity produced from improved Nuruk. It is indicated that the use of improved Nuruk could make high alcohol production as well as improve quality of Yakju and Takju. In Fig. 3, we suggested the effective brewing process using improved Nuruk to obtain traditional alcoholic beverage having high quality.

Table. 4 Properties (free sugar, organic acid, amino acid and volatile compounds) of four kinds of cooked mashes after brewing with Improved-Nuruk

Classification	TYJ*	YJ*	TJ*	SJ*
Free sugar (mg%)				
Glucose	400	1033	385	155
Fructose	44	266	175	202
Sucrose	44	212	75	67
Maltose	149	64	14	14
Organic acid (%)				
Citric acid	0.641	0.566	0.692	-
Tartaric acid	1.066	1.821	1.663	1.724
Malonic acid	0.786	0.020	1.120	0.666
Succinic acid	0.143	0.139	1.614	0.140
Lactic acid	0.569	2.115	2.621	2.219
Acetic acid	0.032	0.034	0.058	0.033
Amino acid (mg%)				
Cystine	-	-	-	-
Methionine	30.63	41.13	42.31	34.80
Aspartic acid	28.59	39.26	41.30	33.71
Threonine	86.68	90.41	93.62	81.27
Serine	38.78	34.73	36.21	29.80
Glutamic acid	86.01	117.77	119.38	101.20
Glycine	39.20	43.80	45.20	37.33
Alanine	83.15	137.52	141.66	143.77
Valine	44.76	54.58	57.78	44.15
Iso-leucine	30.35	30.11	32.35	22.25
Leucine	76.95	96.12	100.47	73.99
Tyrosine	62.64	105.19	108.42	88.09
Phenylalanine	84.09	146.05	105.87	114.38
Lysine	42.02	49.82	52.85	37.14
Histidine	22.40	23.47	24.62	20.17
Arginine	99.09	165.15	174.66	129.92
Proline	76.47	79.34	81.65	75.62
Volatile compounds (ppm)				
n-Propanol	86	115	120	134
Iso-butanol	68	112	126	131
Iso-amyl alcohol	72	107	128	138
Ethyl acetate	87	100	89	103
Iso-butyl acetate	29	28	36	37
Iso-amyl acetate	27	41	40	42

* TYJ : Yakju brewed with traditional Nuruk
TJ : Takju brewed with improved Nuruk
YJ : Yakju brewed with improved Nuruk
SJ : Soju brewed with improved Nuruk

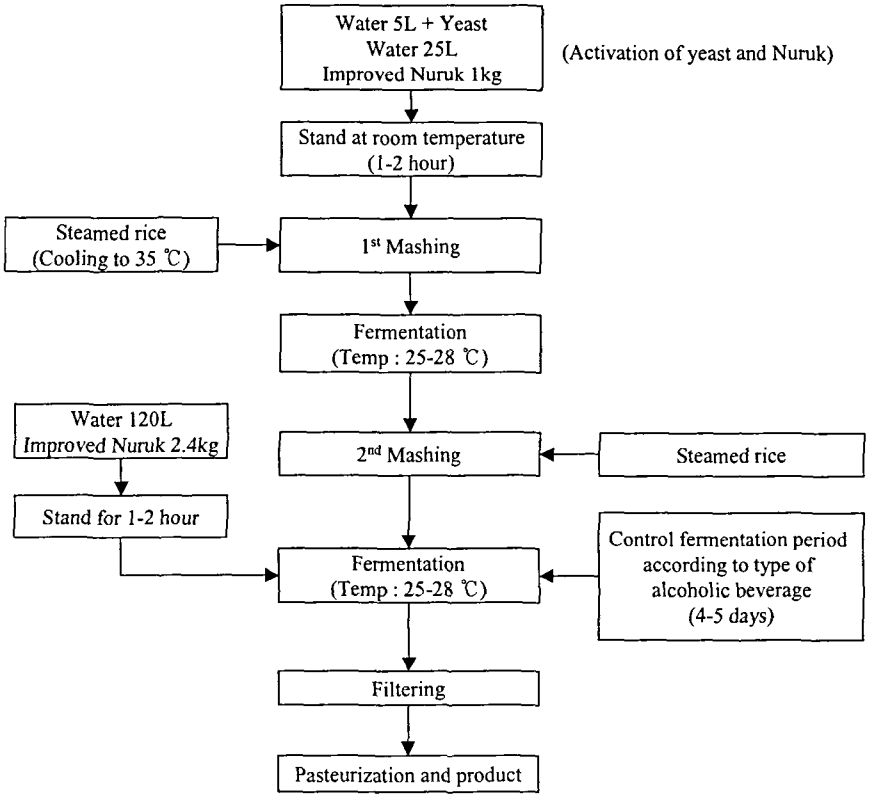

Fig. 3 Brewing process using Improved-Nuruk

5. Conclusion

Development of new type Nuruk has several meanings in brewing industry. Nuruk mainly affected the quality of Korea traditional alcoholic beverage, so that the improvement of quality and saccharogenic power of Nuruk is important point to obtain remarkable growth of traditional brewing industry. Improved-Nuruk could therefore accomplish to resolve the problem in traditional brewing industry such as the easy variation of mash properties, the difficulty of quality control and low quality of products. Improved-Nuruk may also give an economical profit on brewing industry, because smaller use than traditional Nuruk induced by high saccharogenic power reduces the cost of production. In addition, the scientific brewing technique and microbiological theology that applied for the production of improved-Nuruk will provide practical help on the additional problems occurring later.

In conclusion, such development concerning traditional brewing method will play an important role to obtain quality and taste preferred by customing public and thus to revive Korea traditional alcoholic beverage.