J. Fac. Agr. Hokkaido Univ., Vol. 63, Pt. 3: 287~292 (1987)

CHEMICAL AND MICROBIOLOGICAL ANALYSES OF AN INDONESIAN DRIED BEEF —*dendeng sapi*—

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Received July 22, 1987

Introduction

The preservation of meat by the sun drying has been practised for many thousands of years. Lowering the moisture content (dehydration) to prevent foods from spoilage is a well-known method in tropical areas. Such dried meat products are known as *biltong* in South Africa, *charqui* in South America, *pemmican* in North America, *tassajo* in Uruguay, and *dendeng* in Indonesia.[1~3] Since these dried meat products are stored under unrefrigerated conditions for long time, they are suitable and distributable nutritious foods in tropical countries. Unrefrigerated meat products recently gained interest in some parts of European countries because they save energy and thus costs during distribution and storage. This reflects that unrefrigerated meat products, especially traditional products, are very versatile.

Dendeng is a popular traditional Indonesian meat product that has been made for centuries, originating in Java and Bali islands. It may be prepared from beef, chicken, pork, or goat meat, but dried beef, *dendeng sapi*, is the most commonly found in the markets of Indonesia. The preparation of the *dendeng sapi* has not been standardized. It involves slicing the meast to about 2 mm in thickness and soaking for 1 to 6 h in a soaking solution containing palm sugar, cooking salt, and additives such as coriander, caraway seeds, and nitrites. The proportion of ingredients used is variable. The treated meat slices are then dried under sunlight and packaged for sale. However, some hygienic problems are found since these products are being still prepared partly by the traditional home-made type method. The detailed

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chemical and microbiological study seems to be needed to improve the quality and to increase availability of the Indonesian-style dried meat product. Some chemical analyses and bacterial counts were, therefore, carried out in this study.

Materials and Methods

Materials: *Dendengs* (*sapi*) were bought from different retailers at Semarang, Yogyakarta, and Jakarta in Indonesia. The plate count agar and the desoxycholate agar were products of Eiken Chemical Co. Ltd. The Vogel-Johnson agar was a product of Daigo Eiyo-Kagaku Co. Ltd.

Measurement of Nitrite and Nitrate Content: Samples were cut to about 1 mm^3 and homogenized by a blender at 10,000 rpm for 45 sec to extract nitrite and nitrate residues. Concentration of nitrites and nitrates was measured colorimetrically with the Griess reagent by the AOAC method[4] with slight modifications as suggested by HARADA[5] and HARADA *et al.*[6]

Water Activity (a_w): The water activity of each sample was measured by the method of Troller *et al.*[7] with a Rotronic Hygroscope, model DT.

Bacterial counts: Samples were aseptically cut to about 1 mm^3. The sample (2 g) was mixed with 50 ml of sterile dilution buffer containing 0.625 mM KH_2PO_4 (pH 7.2) and 2 mM $MgCl_2$ in a sterile plastic bag. To homogenize samples, the bag containing the mixture was sonicated for 5 min by a Branson Ultrasonic Cleaner, paddled with fingers for 10 min and sonicated again for 3 min at 4°C. Five ml of the homogenized sample was heated in a sterile test tube at 80°C for 10 min to obtain a sample for which the thermoduric bacteria or spore count still remained. The serial dilution was also prepared from homogenized unheated sample.

The following groups of microorganisms were enumerated.

Standard plate counts: The unheated serial dilution was pour-plated on plate count agar and incubated for 2 to 3 days at 35°C.

Thermoduric or Spore counts: The same procedure as above was used with the heated sample.

Staphylococcus aureus: An aliquot (1.25 ml) of the serial dilution was transferred to the Vogel-Johnson medium, then spread over the surface of agar with the inoculum, and incubated at 35°C for up to 48 h. Black colonies surrounded by yellow rings were counted as *S. aureus*.

Coliform counts: Fifteen ml of melted desoxycholate agar was poured into homogenized sample solutions (1 ml) and overlaid with the same agar after solidifying. The plates were incubated at 35°C for 18–24 h. Typical red colonies were enumerated as coliform bacteria.

Results and Discussion

Chemical composition analyses of *dendeng sapi*: The results of the general composition of *dendeng sapi* which were purchased in Indonesia are presented in Table 1. High carbohydrate contents (about 50%) reflects high concentration of sugar in the soaking solution. The moisture content of *dendeng sapi* was about 20%. The a_w values of Chinese intermediate moisture meat products were in the range from 0.54 to 0.68.[8] An average value of a_w of *dendeng sapi* was 0.59 (Table 2). An a_w value below 0.69 is essential for the microbiological stability of Chinese dried meat products and this a_w value is brought about under conditions such as about 4-5% salt, 20-35% sugar and 15-20% water in the product.[8] "Intermediate moisture foods" are defined as foods having a_w from 0.90 to 0.60,[2,8] thus *dendeng sapi* can be classified as an intermediate moisture meat.

Nitrite and nitrate content of *dendeng sapi*: Nitrites are commonly employed as curing agents for meat and fish products. Sodium or potassium nitrites are used to improve the color[9~13] and flavor of products.[11,14,15] It is also known that nitrites can inhibit the growth of *Clostridium botulinum* in certain cured meat products.[11,16~18] However, nitrites have received negative publicity over the last several years, because they can form nitrosamines which are known as potent carcinogens[19,20] and because they have toxic properties.[21] The legally permissible addition concentration of nitrites and nitrates in meat products are 200 and 500 ppm, respectively, in Indonesia. Since there is no legal regulation as to the residual concentration of NO_2^- or NO_3^-, it seems to be difficult for the Indonesian government to control the regulation of nirtite and nitrate levels in meat products. Nirtite content

TABLE 1. General analysis of Indonesian *dendeng sapi*

Composition	Amount (g/100 g)
Moisture	20.9±0.8
Protein	21.8±0.6
Fat	5.5±0.4
Carbohydrate	46.7±0.4
Ash	1.5±0.1
Nitrites[1]	5-93 (ppm)
Nitrates[2]	1,010-2,480 (ppm)

1) Calculated as $NaNO_2$ 2) Calculated as $NaNO_3$

of one *dendeng sapi* was much higher than that of others. Moreover, the samples contained high residual nitrates between 1,000-2,500 ppm (Table 1) that is over the permissible concentration in Indonesia. FACCINI *et al.*[21] reported that doses of 150 ppm of $NaNO_2$ or 250 ppm of KNO_3 must be considered hazardous in meats. To improve the quality of *dendeng*, it is necessary for the manufacture to reduce the amount of nitrites and nitrates.

Bacterial Counts of *Dendeng sapi*: Estimated bacterial counts in *dendengs* can be seen in Table 2. These data indicate that *dendeng sapi* have varying total bacteria. Low bacterial population was found from two samples (samples A and B). Furthermore, the thermoduric bacteria and *S. aureus* from these two samples were also lower than those of the others. Samples C and D had the highest total bacteria and *S. aureus* but low amounts of thermoduric bacteria, whereas samples E and F had lower total bacteria than C and D but the highest amount of thermoduric bacteria. Table 2 also indicates that thermoduric bacteria and *S. aureus* were found in all samples but slight coliform bacteria was found in only two samples.

In *biltong*, a dried salted beef product in South Africa, microorganisms proliferate freely and the bacterial count was from 9.8×10^4 to 3.8×10^7/g.[22] Another investigator[8] reported that Chinese intermediate moisture meat products which have an excellent microbiological stability were populated in the range from 1×10^2 to 5×10^3/g. Total aerobic bacteria in the dried meat products (from 13 different original samples) was in varying amounts from 2×10^3 to 7×10^7/g.[1] This indicates that total becterial count in the *dendeng sapi* (Table 2) is lower than those in *biltong*, higher than those in Chinese intermediate moisture meat, and lower than those in other reports.

SINELL and HEUTSCHEL[1] reported that *S. aureus* was not detected in thirteen dried meat products of a different origin. However, this bacteria was found in all 6 *dendeng sapi* samples (Table 2). Although the production

TABLE 2. Bacterial counts and water activity (a_w)

Sample	Bacterial counts (cell$\times10^{-3}$/g)				a_w
	Total bacteria	Thermoduric	*S. aureus*	Coliform	
A	0.4	0.05	<0.1	0	0.652
B	2	1	<0.1	0	0.604
C	464	2	8	0.2	0.634
D	1,750	5	9	0	0.539
E	209	101	0.02	0	0.559
F	275	106	0.6	3	0.537

of enterotoxin from *S. aureus* was not tested in this study, certain specialized strains of *Staphylococcus* produced enterotoxin which caused food poisoning outbreak.[23] From hygienic point of view, it is necessary to suppress *S. aureus* in the processing of *dendengs* to prevent food poisoning.

Summary

Chemical analyses and bacterial counts of commercial *dendeng sapi* samples from Indonesia were carried out. The samples contained different levels of nitrite (5–90 ppm) and nitrate (1,000–2,500 ppm). *Dendeng sapi* had a_w values between 0.54–0.65. Total bacteria of samples varied from 0.4×10^3 to 1750×10^3/g. Thermoduric bacteria and *S. aureus* were found in all samples. A small amount of coliform bacteria was detected in two of six samples.

Acknowledgment

An author, P. BINTORO, is appreciative of the Ministry of Education, Science, and Culture of Japan for financial support during this study and the Ministry of Education and Culture of Indonesia for permission of the study in Japan.

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