

亜熱帯沖縄におけるヤギの
乳肉生産性向上に関する研究

Studies on the improvement of meat and milk
productivity of goats in the Subtropical Okinawa

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表2-1. 各島嶼集団の表現型頻度と遺伝子頻度

集団番号	集団名	調査頭数			遺伝形質					
		雄	雌	間性	合計	有色 (q_i)	肉髯なし (q_w)	有角 (q_P)	毛髯あり (Q_B)	副乳頭あり (Q_{ST})
1	与那国島	8	31	0	39	48.72% (.6980)	84.62% (.9199)	61.54% (.7845)	64.10%	20.51%
2	石垣島	45	46	0	91	23.08 (.4804)	70.33 (.8386)	84.62 (.9199)	68.13	30.77
3	波照間島	40	35	0	75	0.00 (.00)	88.00 (.9381)	76.00 (.8718)	72.00	10.67
4	多良間島	45	77	1	123	6.50 (.2550)	75.61 (.8695)	67.48 (.8215)	71.54	29.27
5	宮古島	30	70	2	102	7.84 (.2801)	67.65 (.8225)	28.43 (.5332)	66.67	22.55
6	久米島	9	25	0	34	32.35 (.5688)	76.47 (.8745)	73.53 (.8575)	67.65	2.94
7	粟国島	12	46	0	58	8.62 (.2936)	70.69 (.8408)	94.83 (.9738)	67.24	1.72
8	伊平屋島	17	39	0	56	35.71 (.5976)	89.29 (.9449)	60.71 (.7792)	76.79	26.79
9	伊是名島	19	32	0	51	7.84 (.2801)	70.59 (.8402)	66.67 (.8165)	72.55	15.69
10	沖縄県中南部	165	311	8	484	15.91 (.3989)	73.97 (.8600)	45.45 (.6742)	46.90	12.81
11	沖縄県北部	84	134	7	225	8.44 (.2906)	72.44 (.8511)	30.67 (.5538)	46.67	7.11
合計		474	846	18	1,338	17.73% (.3766)	76.33% (.8595)	62.72% (.7805)	65.48%	16.44%
日本ザーネン種						(.0607)*	(.8280)*	(.5559)*		1.36*

() : 遺伝子頻度, * Nozawa (1970).

表2-3. 外部形質に及ぼす自然および人為淘汰

組合せ	集団番号											サイン数	サインテスト (χ^2)	
	1	2	3	4	5	6	7	8	9	10	11			
$qI - Ew$ (qI)	-0.135	-0.362	0.662	0.032	-1.047	-0.254	-0.163	0.102	-0.153	-0.164	-0.104	3	-8	2.27
$qI - Ep$ (qI)	-0.154	0.350	0.729	0.368	-0.267	0.130	0.651	-0.065	0.332	-0.088	-0.234	6	-5	0.09
$qI - EST$ (qI)	-0.505	-0.140	0.149	0.071	-0.018	-0.493	-0.230	-0.295	-0.082	-0.229	-0.175	2	-9	4.45*
サイン数												11	-22	3.67
$qW - EI$ (qW)	0.025	0.066	-0.121	-0.006	0.046	0.047	0.030	-0.019	0.028	0.030	0.018	8	-3	2.27
$qW - Ep$ (qW)	-0.003	0.130	0.012	0.061	-0.003	0.070	0.149	-0.030	0.089	0.014	-0.024	7	-4	0.82
$qW - EST$ (qW)	-0.059	0.041	-0.094	0.007	0.042	-0.044	-0.012	-0.073	0.013	-0.012	-0.013	4	-7	0.82
サイン数												19	-14	0.76
$qp - EI$ (qp)	0.073	-0.166	-0.345	-0.174	0.126	-0.061	-0.308	0.031	-0.157	0.042	0.107	5	-6	0.09
$qp - Ew$ (qp)	0.009	-0.337	-0.032	-0.158	-0.369	-0.182	-0.385	0.079	-0.229	-0.036	0.062	3	-8	2.27
$qp - EST$ (qp)	-0.142	-0.232	-0.274	-0.140	0.118	-0.295	-0.416	-0.189	-0.196	-0.067	0.028	2	-9	4.45*
サイン数												10	-23	5.12*
$QST - EI$ (QST)	0.478	0.147	-0.157	-0.075	0.019	0.518	0.241	0.310	0.087	0.241	0.176	9	-2	4.45*
$QST - Ew$ (QST)	0.336	-0.233	0.558	-0.041	-1.081	0.251	0.070	0.416	-0.073	0.069	0.075	7	-4	0.82
$QST - Ep$ (QST)	-0.399	0.514	0.609	0.311	-0.262	0.654	0.925	0.242	0.436	0.148	-0.062	8	-3	2.27
サイン数												24	-9	6.82*

* $P < 0.05$

表3-5. ポア一種の各測定部位間の相関係数

部 位	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₃
体 高 (X ₁)		0.729	0.557	0.945**	0.887*	0.920**	0.883*	0.875*	0.873*	0.961**	0.932**	0.950**	0.777
斜 体 長 (X ₂)	0.788**		0.486	0.836*	0.465	0.484	0.708	0.937**	0.554	0.810	0.924**	0.590	0.973**
十 字 部 高 (X ₃)	0.766**	0.609**		0.664	0.760	0.617	0.489	0.678	0.393	0.724	0.578	0.428	0.467
腰 角 幅 (X ₄)	0.494*	0.799**	0.528*		0.811	0.823*	0.812*	0.950**	0.696	0.987**	0.968**	0.836*	0.816*
か ん 幅 (X ₅)	0.486*	0.695**	0.442	0.816**		0.965**	0.795	0.711	0.805	0.879*	0.739	0.867*	0.538
座 骨 幅 (X ₆)	0.268	0.347	0.240	0.426	0.525*		0.887*	0.686	0.809	0.880*	0.773	0.956**	0.571
尻 長 (X ₇)	0.298	0.408	0.043	0.473	0.582*	0.447		0.757	0.787	0.861*	0.870**	0.943**	0.809
肩 端 幅 (X ₈)	0.603*	0.666**	0.268	0.554*	0.521*	0.387	0.419		0.699	0.944**	0.970**	0.718	0.918**
胸 幅 (X ₉)	0.492*	0.791**	0.337	0.771**	0.700**	0.504*	0.386	0.817**		0.760	0.745	0.856*	0.685
胸 深 (X ₁₀)	0.488*	0.722**	0.377	0.832**	0.713**	0.343	0.266	0.696**	0.844**		0.962**	0.871*	0.821*
胸 囲 (X ₁₁)	0.554*	0.792**	0.362	0.794**	0.789**	0.458	0.498*	0.831**	0.905**	0.906**		0.839*	0.931**
管 囲 (X ₁₂)	0.306	0.042	0.186	0.039	-0.014	-0.015	0.181	0.309	0.235	0.092	0.138		0.686
体 重 (X ₁₃)	0.847**	0.909**	0.673*	0.954**	0.894**	0.604	0.309	0.907**	0.933**	0.884**	0.974**	-0.029	

右上は雄の相関係数, 左下は雌の相関係数.

* p<.05, ** p<.01.



図5-9 羊肉専門店(台北市)



図5-10 高級品らしく展示(台北市)



図5-11 夜市のヤギ料理の屋台(台北市)



図5-12 大型のヤギ料理店(宜蘭市)



図5-13 ヤギ肉青菜炒め(苗栗市)



図5-14 漢方薬入りのしゃぶしゃぶ(台北市)



図5-31 ハノイ市内のヤギ料理店

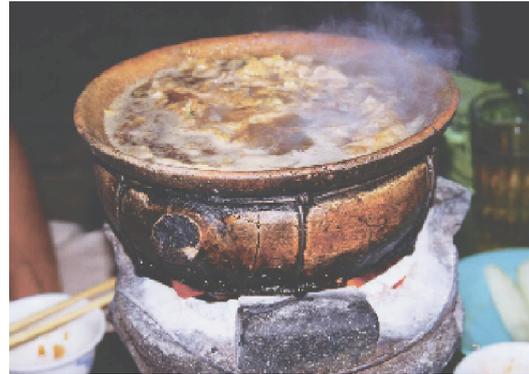


図5-32 七輪に土鍋のヤギ鍋(ハノイ市)



図5-33 乳房のスライス焼き



図5-34 ヤギ肉とレモングラス炒め

A. ヤギ鍋(ハノイ市)

ヤギ肉を主体に、湯葉や豆腐、タケノコ、ネギ、セリなどの野菜を入れて煮るヤギ鍋は多くの国民に好まれている(図5-32)。鍋で煮た肉と野菜を、レタスやカラシナなどできりみ、さらにライスペーパーで包み(図5-33参照)、甘味噌風味のタレをつけて食べる。ヤギ鍋の最後はフォー(米製の麺)を入れて食する。

B. 雌ヤギの乳房のスライス焼(ハノイ市)

①薄くスライスした雌ヤギの乳房を七輪で焼く。②それをレタスやセリなど

6) インドネシア

2005年におけるインドネシアの人口は、約2億2千万人となっており(国立社会保障・人口問題研究所 2007), その約90%はイスラム教徒である(外務省編集協力 2007)。イスラム教徒は、豚肉を禁忌としているため、ヤギ肉と羊肉がもっとも多く利用されている。ヤギは各地で飼養されている(図5-37)。各地のバザール(市場)では、ヤギ肉販売店が多くみられる(図5-38)。



図5-37 舎飼いのヤギ(ジョグジャカルタ)



図5-38 市場のヤギ肉店(ジョグジャカルタ)



図5-39 サテ・カンビンを焼く



図5-40 舗道上のヤギ料理の屋台(ジョグジャカ)

ヤギはカンビンと称している。サテ・カンビン(ヤギ肉の串刺し)は、タレをつけながら炭火で焼く。焼き方や味も日本の焼き鳥とよく似ている(図5-39)。

表5-4. 沖縄と東アジアにおけるヤギ料理の分類

国（地方）	汁物	煮込み	鍋物	炒め物	その他
沖縄	ヤギ汁 (図5-3)			チーイリチャー (図5-6)	刺身 (図5-5)
	タケノコ入りスープ		漢方薬入りしゃぶしゃぶ (図5-14) 並しゃぶしゃぶ	胃袋とセリの沙茶醬炒め ヤギ肉青菜炒め (図5-13)	バーベキュー (図5-16) 若齢ヤギのソーキ炙り焼 (図5-15)
台湾					
フィリピン	シナンパローファン (図5-24)	カルディレーター (図5-23) アドボ		サルピカウ	キラウイン パーパイータン
韓国	ヤギ骨スープ		ヤギ肉しゃぶしゃぶ (図5-28) 蒸しヤギ肉鍋 (図5-27)	内臓と野菜炒め	焼き肉
			ヤギ鍋 (図5-32)	ヤギ肉とレモングラス炒め (図5-34)	乳房のスライス焼 (図5-33) 発酵ヤギ肉 (図5-36) 生血のプデイン (図5-35)
ベトナム					
インドネシア	ソップ・カンビン (図5-42)	カレ・カンビン			サテ・カンビン (図5-39)
		トンセン・カンビン			カンビンナシゴレン (図5-41) カンビンミーゴレン
インド		ヤギカレー (図5-46)			

S U M M A R Y

Okinawa already has the highest number of breeding goats in Japan and has a culture of using goats as a source of meat. However, in recent years there has been a decreasing trend in the number of goats produced in the region. Because of this, research was conducted on the types and genetic traits of meat producing goats in Okinawa in order to restore the goat population. The research also clarified the process of improvement and the actual state of meat and milk consumption. In addition to this, the types of goat dishes consumed in East Asia were surveyed and compared to the food culture in Okinawa.

It has been 80 years since the Japanese Saanen were brought in to Okinawa prefecture to improve the Okinawa meat goats. Morphogenetic characters of the Okinawa meat goats were analyzed using 1,338 goats of approximately 5 months of age and older belonging to eleven populations raised on ten different islands. The frequencies of genes for colored coat (*i*), Wattleless (*w*) and horned (*p*) were $q_i=0.377$, $q_w=0.860$ and $q_p=0.781$ respectively. The phenotype frequencies of goats with beards and with supernumerary teats were 65% and 16% respectively. At present, the migration rate of the Japanese Saanen into the Okinawa meat goats is calculated by 4 morphogenetic characters. The average gene flow from the Japanese Saanen into the Okinawa meat goats was 69% as a whole. The migration rate into the goats in Iheya (50%) and Yonaguni Island (52%)

was lower than those in other islands, while the rate in Miyako (91%), North Okinawa (89%) , South-Central Okinawa Island (77%) was high. There is a noticeable polarized gap developing between the islands. The possibility of selection in coat color, wattles, horns and supernumerary teats was analyzed and the results showed that horned (*p*) and lacking supernumerary teat genes were positively selected.

A hybrid breed of the native Okinawa goat and the Japanese Saanen breed, meat producing goats in Okinawa have undergone continual improvement for the last 80 years. The goats are unexpectedly small with the male and female weighing 33kg and 31kg respectively. The goats with the closest genetic links to the Japanese Saanen are susceptible to cerebrospinal filariasis and mastitis and therefore the chance of them being culled is higher. In order to compensate for this shortcoming, 9 female and 2 male Boer goats were imported from the USA in 1999 to improve Okinawa meat goats. The Boer goats in Okinawa were investigated to ascertain delivery season, number per litter, morphogenetic characteristics and body measurement. Both Boer goats and Okinawa meat goats had a peak delivery period ranging from January to April. There was no difference between the two groups. The Boer goats had a shortened breeding season and there were no kids delivered from August to October. On the other hand, Okinawa meat goats had a low delivery rate from May to December and exhibited slow but constant breeding throughout the year. Average litter sizes of Boer and Okinawa meat goats were 1.6 and

1.0, respectively. The coat color of the Boer goats was white with a brown face, neck and horns. The animals had no wattles. However, the supernumerary teats and beard of the female goats were variable. The average body weight, withers height, chest girth and shoulder point width in females and males were 44.7, 67.7kg ; 66.6, 76.3cm : 84.8, 91.3cm : 19.7, 2.0cm, respectively. The phenotypic correlations were calculated between every possible pair of 13 traits in both the females and males.

Significantly high correlations between body weight and chest girth, chest width and hip width were obtained. The Boer goats are different to local goats in that their forequarters are well developed, they grow well, they are broad and deep in the chest with high body weights, meaning their dressed carcass ratio is also high. Because of this, significant changes are expected among the population of Okinawa meat producing goats.

Goat meat dishes in Okinawa are simple with the most popular being soup. The meat is also eaten both raw and in fried dishes. The fact that younger generations increasingly shun goat meat is however, cause for concern. Therefore, in order to increase the acceptance of goat meat consumption in Japan, a survey of East Asian goat meat dishes was carried out.

Goat meat is used in a variety of dishes in East Asia including flame broiled ribs from young goats in Taiwan, goat meat in the Philippines is eaten as a mixed stew, it is casseroled in Korea, fried with lemon grass in Vietnam, kabobs in Indonesia, and used in curry in India. Due to religious

beliefs, goat meat is of particular dietary importance in areas with large Hindu and Muslim populations such as India and Indonesia. It is thought that goat meat dishes such as kababs, casseroles with Chinese herbs, and curry need to be introduced to Okinawa. Introduction of a variety of new dishes to menus could be expected to drive an expansion of demand for goat meat.

The recent years, goat milk has been gaining popularity again because of its low allergenic properties. Goat cheese and yogurt are also gaining favor.

Monthly changes of milk production and composition were investigated on goats in Hagoromo farm located in the central area of Okinawa Island from April, 2006 to March, 2007. The number of animals daily milked changed from 15 to 60 through the year. The total of Milk yield was 14,285 kg a year, but 83% (11,845 kg) of yearly total milk production was during 7 months from April to October. The average milk yield was 39kg/head/month. The average milk yield was 0.86 kg/head/year. Milk fat content decreased to below 3% from July to November but improved to above 3% from December to March. Additionally NSF decreased to below 8% from June to November but improved to above 8% from December to January. The correlation was between temperature, milk fat and NSF.

Temperature had significantly and negatively correlated with milk fat content ($r=-0.935$, $p<0.01$) and NSF content ($r=-0.820$, $p<0.01$), but positively correlated with daily milk yield ($r=0.964$, $p<0.01$). Pursuit of improvements in milk yield during winter and composition during summer are the problems

which confront farmers in the daily management of goat production in Okinawa.

It is thought that the development of highly productive meat producing goats, new dishes to suit modern tastes, development of low cost goat based products, and the stabilization of milk production and milk component yield would help increase the number of goats and positively contribute to goat production in East Asia.

Farmer's willingness to produce will rise if the risks are low, and if goat's milk, meat, and these finished goods are widely accepted as everyday consumables. The demand for goat products drives the need for improvement of the breeds. Without sufficient demand there is no need to improve the overall productivity of the goats. Therefore, quality products are needed to stimulate market demand and drive improvement and expansion in the industry.

These factors are considered to be most important in order to improve the productivity of the goat.