

BEEF MEAT QUALITY IN JAPAN

V.H. POWELL AND K. OZUTSUMI

CSIRO Meat Research, Division of Food Science & Technology, PO Box 12, Cannon Hill, Brisbane, Q. 4170, Australia.
National Institute of Animal Industry, MAFF, PO Box 5, Tsukuba, Ibaraki, Japan.

Background

For many centuries Japanese were prohibited from eating the flesh from four legged animals. Only over the past 100 years has this decree been relaxed. Consumption of beef has dramatically increased from less than 1 kg per person ten years ago to over 5 kg per person today. Historically, the people of western Japan (e.g. in the cities of Nagoya, Osaka, Kobe, etc, on Honshu and on the islands of Kyushu and Shigoku) have eaten more beef than the people of eastern Japan (including Tokyo and Yokohama). A conceivable reason for this was the nearness of the famous Wagyu breeding grounds which meant that fresh beef was readily available.

Japanese black cattle, better known in the west as Wagyu, are characterised by considerable marbling. Its price varies greatly, dependent on the amount of marbling, and it can be very expensive. The cost in Japan of beef production, slaughtering, packing, etc, is very high because of the small number of animals per farm, about 10, the small throughput through the meatplants, and, the high cost of labour. Japan's carcass production in 1994 was about 600,000 tonnes. Imported beef comes from Australia (market share is 52% with 175,000 tonnes of chilled and 65,000 tonnes of frozen) and the United States (market share is 43% with 74,000 tonnes chilled and 122,000 tonnes frozen). Less than 5% is imported from Canada and New Zealand. In 1994 the output of Wagyu beef, the product regarded as high quality beef, was only 210,000 tonnes. Long term fattening and 30 months is not unusual, of Wagyu is considered to be an ideal diet regimen to produce beef cattle for the high quality markets of Japan.

Methodology

Various breeds of Japanese cattle were slaughtered in commercial and the Institute's abattoir. Primals were removed after ageing the carcasses for four or five days. Selected cuts were vacuum packaged and aged for two weeks. Standard methods were used for chemical, biochemical and physical analyses.

Beef Quality

Japanese carcasses are graded for meat quality into one of five grades. The main attributes for grading, in descending order of importance are:

1. Marbling,
2. Colour and brightness of meat,
3. Meat firmness and texture
4. Fat colour, lustre and texture.

Only a small portion (10%) of all the Wagyu carcasses in Japan are graded as grade "5". This is the highest quality grade. The following are approximate percentages of the carcasses which fall within the other grades: grade "4" is 13%, grade "3" is 30%, grade "2" is 35% and grade "1" is 13%.

Yield of boneless cuts from a carcass is rated into one of three rankings; A = a yield of 72% or more, B = a yield of 69 to 71.9%, and C = a yield less than 69%. Accordingly, the overall grade of a carcass is assigned from one of 15 classes according to its yield and its quality scores, e.g. A3. Grading of carcasses forms the basis of the pricing structure within the meat trade; farmers use it as the basis of their production, wholesalers use it for trading, and consumers use it by default through the price mechanism.

Sides of beef in Japan are initially cut into 13 prime cuts: nekku (chuck), ude or kata (shoulder), katarosu (chuck roll), katabara (point end brisket), hire (fillet), rib roosu (cube roll), saaroin (striploin), tomobara (flank and navel end brisket), uchimomo (topside or inside),shintama (knuckle), ranichi (rump), sotomomo (silverside or outside) and sune (shin). Retail cuts are then prepared (see later). There is a huge range in the retail price for meat from about 500 Yen/kg (US\$5) for ground beef to 50,000 Yen/kg (US\$500) for shabu shabu. Most beef is aged for 7 to 10 days in vacuum packages.

The quality of food (Ozutsumi 1994) is closely related to its functions which can be divided into two categories: basic and functional. The basic characteristics are the nutrients in food, such as protein, fat and carbohydrates, fibre, vitamins, minerals. The most important issue within the functional characteristics of meat is the taste. By far the most important component of taste is the dynamic property - tenderness. Taste properties are further classified into flavour and odour.

Table 1 shows the characteristics of the carcasses from Wagyu, Holstein and their cross breeds produced in Japan. Wagyu cattle are smaller than Holstein and the cross breeds are of intermediate size. However, Wagyu has a greater dressing percentage, yield percentage, rib eye area and meat quality grade than the other two breeds and this is reflected in the prices for cattle and meat. Table 2 shows the correlation coefficients between the various items recorded for carcasses from Wagyu and Holstein. With Wagyu, price (Item No 15) has a high correlation with marbling (No 8, 9 & 10), firmness and texture (No 12 & 13); with Holstein, price is correlated to dressing percentage, yield percentage, rib thickness, fat thickness, meat quality, and, marbling (Item No 3, 4, 6, 7, 8 & 10).

The chemical and physical analyses of the M. longissimus thoracic of Japanese black Wagyu for each quality grade of carcass are listed in Table 3. As the quality grade decreases, the moisture level increases from 56% to 65%, and as expected, the fat content decreases from 25% to 13%. Similarly, as the quality grade from Wagyu decreases, the weep from chilled, vacuum packaged primals increases as the moisture content increases. The shear force values are consistent with the meat being very tender for grade "5" and becoming marginally tougher as the grade decreases. As the quality grade from Wagyu decreases, the L* value decreases. This is consistent with the decrease in fat content. The high L* value for grade "5" Wagyu is undoubtedly due to the high levels of marbling in this meat.

Table 4 lists the ratios of unsaturated to saturated fats for the various breeds. The cattle were sourced from a total of 19 Japanese Prefectures, Kyushu in the south to Hokkaido in the north, over a one year period, (Powell, 1993). Note the high level of unsaturated fat in all breed types fed in Japan; the ratio of unsaturated to saturated fat is about 2.00. Even the Australian Murray Grey cattle fed in Japan have similar values. Subcutaneous fats which have an unsat. to sat. ratio of about 2.0, are soft at temperatures below 5°C. With cattle fed in Australia, the ratio is much lower at 1.0 and the fats are much harder. Yang, et al. (1995) discusses this in detail.

The changes in pH and tenderness during ageing are shown in Figures 1 & 2. As expected the rate of decrease in pH varies from muscle to muscle but the ultimate pH is about 5.4. The meat is tender immediately after slaughter and is much tougher at 24 h. After conventional ageing for seven to ten days the meat becomes tender again.

Japanese consumers still buy most of their food requirements on a daily basis. Meat and fat colours are of primary importance to the consumer during the purchasing process of a tray of meat. However, once the product is paid for, the ultimate requirement is to have an enjoyable experience which includes, soft to the mouth (tenderness) and a familiar taste.

Primal cuts used in the preparation of traditional Japanese cuisine

- (a) Shabu Shabu - 1 mm slices dunked in boiling water and eaten with vegetables. Mainly highly marbled loin or shoulder cuts are used.
- (b) Sukiyaki - 2 mm slices meat cooked in hot oil and eaten with raw egg and vegetables. Mainly highly marbled loin and shoulder cuts are used but marbled topside will suffice.

- (c) Sashimi - 4 mm raw meat from highly marbled loin cuts, chuck roll and chuck tender are used.
- (d) Yakimiku - 5 mm slices for barbecued meat on wire mesh and eaten with vegetables. From highly to moderately marbled loin, forequarter (chuck roll, brisket) and rib cuts (short plate) are used.
- (e) Korean Barbecue - as for Yakimiku but meat is prepared in marinade and vegetable mix is different. Mainly butt, forequarter and rib cuts are used.
- (f) Teppanyaki - or a mixed grill, beef (loin cuts and topside), with fish, chicken and sliced vegetables. Meat bought as blocks about 100 x 45 mm.
- (g) Tataki - is partially cooked meat (like a rare roast). From selected muscles (moderate marbling but low marbling acceptable) from fore- and hind-quarter cuts (chuck tender, semimembranosus) are used.
- (h) Nikujaga (literally meat with potatoes) - 2-3 mm sliced meat (inexpensive cuts from chuck, brisket, topside) is boiled with potatoes and other vegetables.
- (i) Gyudon - boiled rice topped with 2 mm sliced beef. Inexpensive cuts from chuck, short plate, topside, round and silverside are used.

Primal cuts used in the preparation of Western style cuisine

- (a) Roast beef - butt cuts; (b) Steak - 10 mm loin cuts; (c) Chinese dishes - 2 mm sliced butt and loin cuts;
- (d) Corned and dried beef - butt and forequarter cuts. Corned beef is not popular; Beef Jerky is popular; (e) Less than 5% of meat is sold as ground beef.

Conclusion

Western foods are very popular but so too are the traditional foods. The high intramuscular fat content or marbling in meat is important for tenderness with traditional Japanese cuisine. The amount of fat makes very little impact on the overall intake of fats to the diet. With all cuts tenderness of meat is of paramount importance followed by a familiar flavour and odour with the meat. A strong, unfamiliar odour is unacceptable.

Pertinent Literature

- Ozumi, K. 1994. Farming Japan, 28, 19
- Powell, V.H. 1994. Chilled beef in Japan. CSIRO Meat Research Report, A 93.
- Yang, A. Larson, T. and Tume, R. 1995. 41 st ICOMST, San Antonio, USA

Fig. 1. Changes in pH of various muscles of beef during storage at 2°C

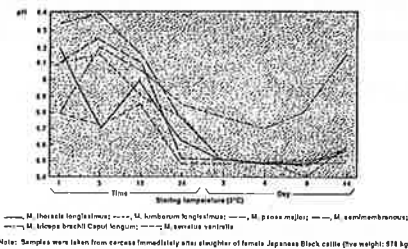


Fig. 2. Changes in hardness in various muscles of beef during storage at 2°C

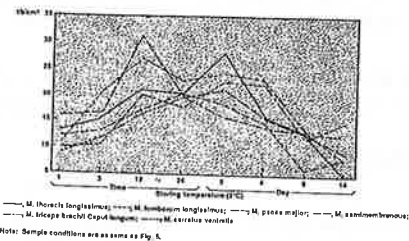


Table 1: Carcase characteristics of various breeds of Japanese cattle

	Wagyu Black (209)	Holstein (41)	Cross Breed of W. and Hol. (13)
Live weight (kg)	662.0	719.2	683.3
Cold carcase weight (kg)	409.0	425.7	414.3
Dressing percentage (%)	62.0	59.1	60.4
Yield estimated percentage (%)	72.9	69.8	70.8
Rib-eye area (cm ²)	47.5	41.2	46.2
Rib thickness (cm)	7.3	6.4	6.5
Subcutaneous fat thickness (cm)	2.7	2.1	2.1
Meat quality (1-5)	3.8	2.2	2.7
BMSNo* (1-12)	5.8	2.6	3.9
Beef marbling (1-5)	3.9	2.5	3.0
BCSNo** (1-7)	4.0	4.3	4.5
Firmness score (1-5)	3.8	2.2	2.9
Texture score (1-5)	4.1	2.5	3.2
BFSNo*** (1-7)	2.6	2.0	2.2
Price (yen/kg)	2,074	1,143	1,589

* BMSNo: beef marbling standard; ** BCSNo: beef colour standard; *** BFSNo: beef fat colour standard

Table 2: Correlation coefficients of each items for Japanese Black Wagyu and Holstein cattle

	Japanese Black Wagyu (303 head)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 Live weight (kg)	0.95	-0.04	-0.16	0.32	0.50	0.23	0.00	-0.05	-0.02	-0.04	0.00	-0.02	0.00	0.00	0.03
2 Cold carcase weight (kg)	0.95	0.26	-0.21	0.32	0.68	0.32	0.02	-0.05	-0.02	-0.07	0.02	0.01	0.00	0.01	0.01
3 Dressing percentage (%)	0.09	0.39	0.15	0.04	0.30	0.31	0.04	0.01	0.00	-0.09	0.04	0.10	0.00	0.00	0.09
4 Yield estimated percentage (%)	-0.10	-0.12	-0.04	0.67	0.21	-0.66	0.21	0.27	0.24	0.05	0.18	0.16	0.03	0.30	0.30
5 Rib-eye area (cm ²)	0.38	0.45	0.35	0.59	0.30	-0.17	0.18	0.21	0.19	-0.07	0.14	0.11	0.07	0.26	0.26
6 Rib thickness (cm)	0.42	0.53	0.49	0.50	0.59	0.24	0.20	0.17	0.13	-0.12	0.20	0.20	0.02	0.31	0.31
7 Subcutaneous fat thickness (cm)	0.24	0.39	0.53	-0.51	0.27	0.20	-0.03	-0.06	-0.07	-0.03	-0.01	0.01	0.04	0.05	0.05
8 Meat quality (1-5)	0.10	0.16	0.25	0.50	0.33	0.53	-0.17	0.88	0.92	-0.39	0.94	0.85	-0.07	0.76	0.76
9 BMSNo* (1-12)	0.08	0.15	0.25	0.52	0.34	0.54	-0.18	0.88	0.92	0.33	0.86	0.81	-0.06	0.74	0.74
10 Beef marbling (1-5)	0.15	0.25	0.38	0.51	0.38	0.62	-0.14	0.85	0.92	-0.34	0.88	0.80	-0.05	0.69	0.69
11 BCSNo** (1-7)	0.17	0.08	-0.29	-0.43	-0.18	-0.42	0.14	-0.30	-0.31	-0.44	-0.41	-0.43	-0.05	-0.42	-0.42
12 Firmness score (1-5)	0.15	0.21	0.25	0.49	0.38	0.52	-0.13	0.96	0.87	0.87	-0.38	0.86	-0.08	0.74	0.74
13 Texture score (1-5)	0.12	0.17	0.21	0.45	0.18	0.52	-0.27	0.89	0.84	0.81	-0.31	0.85	-0.05	0.71	0.71
14 BFSNo*** (1-7)	0.18	0.18	0.04	0.07	0.06	0.12	-0.05	0.06	0.06	0.04	0.18	0.09	0.04	-0.03	-0.03
15 Price (yen/kg)	0.04	0.14	0.24	0.10	0.15	0.60	0.38	0.67	0.61	0.68	-0.41	0.67	0.69	0.16	0.16
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

* BMSNo: beef marbling standard; ** BCSNo: beef colour standard; *** BFSNo: beef fat colour standard

Table 3: Physical and chemical analyses of the M. longissimus thoracis of 77 Japanese Black Wagyu steers in each meat quality score graded by JMGA#

	Meat quality score (head)				Average 3.5
	5 (14)	4 (26)	3 (22)	2 (15)	
Moisture (%)	56.2	60.6	62.1	64.7	61.0
Crude fat (%)	25.3	19.3	17.0	13.4	18.6
Crude protein (%)	17.1	19.0	19.8	21.2	19.3
pH	5.5	5.5	5.5	5.4	5.5
Cooking loss (%)	19.9	22.0	23.5	25.1	22.7
Shear force value (lb/cm ²)	5.5	7.1	7.7	9.2	7.4
Total pigment (mg %)	17.8	19.1	21.0	19.6	19.5
L*	44.3	41.2	38.3	39.2	40.6
a*	19.7	21.1	20.4	20.2	20.5
b*	15.7	15.6	14.7	14.7	15.2

JMGA means Japanese Meat Grading Association

Table 4: Ratio of unsaturated to saturated fatty acids from Japanese and Australian cattle fed in Japan and fed in Australia

	Wagyu Black (10)*	Wagyu Red (5)*	Holstein (60)**	F1 Cross (30)**	Australian Murray grey fed in Japan (30)**	Australian cattle fed in Australia (50)†
Saturated fat %	32.0	32.0	34.0	34.2	32.9	47.3
Mono-unsaturated fat %	61.8	62.4	60.7	59.2	60.1	46.2
Poly-unsaturated fat %	3.9	3.3	3.4	4.2	3.8	2.9
Ratio of unsat. to sat. fat	2.1	2.1	1.9	1.9	2.0	1.0

* Fed 2 years ** Fed 1 year † Fed 150 days