Hindawi
Journal of Food Quality
Volume 2019, Article ID 7608404, 11 pages
https://doi.org/10.1155/2019/7608404

Research Article

Visible Fat Content of Hotpot Beef Acceptability by New Zealand Chinese, Japanese, and Korean Consumers

M. M. Farouk[1], **M. Staincliffe**[1], **D. L. Hopkins**[2], **G. Wu**[1], **C. Che**[3], **A. E. D. Bekhit**[4], **M. J. Y. Yoo**[5], **A. Horita**[1], **G. Urquiola**[5], **C. Craigie**[1], **K. Taukiri**[1], **R. Zhang**[1,5], **H. Ho**[6] and **M. J. Challies**[1]

[1]*AgResearch Limited, Ruakura Research Centre, Hamilton, New Zealand*
[2]*Centre for Red Meat and Sheep Development, NSW Department of Primary Industries, Cowra, Australia*
[3]*China University of Petroleum, Qingdao City, Shandong Province, China*
[4]*Department of Food Science, University of Otago, Dunedin, New Zealand*
[5]*Auckland University of Technology, Auckland, New Zealand*
[6]*University of Auckland, Auckland, New Zealand*

Correspondence should be addressed to M. M. Farouk; mustafa.farouk@agresearch.co.nz

Received 8 March 2019; Revised 24 May 2019; Accepted 18 August 2019; Published 15 October 2019

Guest Editor: Carlos Álvarez

Hotpot meat is a popular way of meat consumption in some Asian countries. This study was carried out to investigate the effect of visible fat content on consumer acceptability of hotpot meat. Hotpot beef with six visible fat levels (11%–35%) was produced and digitally photographed, and the images were ranked by panels of New Zealand Chinese (110), Japanese (145), and Korean (118) consumers. For all the nationalities, a preference for visible fat was influenced by both gender and age. The Chinese preferred the visibly fattiest hotpot beef, whereas the Koreans preferred the leanest with the Japanese preferring the two fat extremes equally. For individuals in the age range of 19–30 years, both Chinese males and females preferred the higher fat meat (35%), while their Japanese and Korean counterparts preferred the second visibly leanest (14%). For those over 50 years, Chinese females preferred the lower fat meat compared to their male counterparts, whereas there was no gender difference at this age for the Japanese and Koreans preference for the visibly lean hotpot beef. This study indicates that there are subtle differences between nationalities in terms of their preference for the fat content of hotpot beef that may have implications in meat merchandising, product development, and health policies.

1. Introduction

One of the popular forms for eating red meat is hotpot in China or its variants *shabu-shabu* and *jeongol* in Japan and Korea, respectively [1, 2]. Hotpot meat is a rolled, thinly sliced, whole-tissue, or restructured meat, often sold frozen in order to maintain the rolled appearance and form (Figure 1). The meat is usually cooked from frozen in a metal pot containing a simmering soup made of vegetables, spices, and seafood; the cooked pieces are then removed and eaten with a dipping sauce using chopsticks [1].

Any cut of meat can be used for making hotpot, although the cheaper, fattier, or well-marbled cuts are generally used. With an increasing awareness of health-related issues concerning fat consumption and the growing availability of cheaper lean bull/buffalo beef, there is the potential to replace the fattier cuts with lean meat. If this is the case, there is an opportunity for exporting countries to add value to lean meat by turning it into hotpot logs for the domestic Asian markets and for export to Asian countries [3, 4]. For this goal to be achieved, the first question that needs to be addressed is as follows: What is the consumers' preference for hotpot meat in terms of leanness in those countries? And as meat cut/product aesthetics and intrinsic qualities, such as fat content, colour, and appearance, are also important to consumers [1, 5], what would the impact of visible fat

Figure 1: Stages of hotpot meat production and consumption. (a) Restructured/formed hotpot beef log being sliced using a hotpot slicer; (b) rolled hotpot slices ready for cooking; (c) hotpot meat pieces being dipped in a simmering hotpot soup.

content be on the acceptability of hotpot meat by Asian consumers? Hence, the objective of this study was to determine the preference of New Zealand Chinese, Japanese, and Korean consumers in terms of the visible fat content of hotpot beef. The long-term goal is to provide insight regarding the preference for hotpot meat that exporting countries could use to add value to lean meat for export to China, Japan, Korea, and other Asian markets where hotpot and thinly sliced meat are acceptable formats for meats.

2. Materials and Methods

2.1. Sample Preparation and Imaging. Frozen boxed 65–95 CL (chemical leanness) manufacturing beef from bulls, cows, and steers of normal pH (5.6-5.8) were thawed overnight at 10°C, sorted, and combined to obtain a range of visible fat content. It was restructured into a log by orienting the muscle fibres and fat to provide a sliced hotpot beef appearance typical of that obtained in hotpot butcheries and grocery stores. The fat content of the logs was varied to produce sliced hotpot with a range of visible fat (Figure 1).

The logs were frozen to −18°C and held at that temperature until ready to be sliced. The logs were then tempered to −3 to −5°C and sliced (2-3 mm thick) using a hotpot slicer (Figure 1). The sliced hotpot was placed on white polystyrene trays, overwrapped with an oxygen-permeable film, and held at −18°C until used.

The packaged hotpot slices were photographed using a Canon EOS 550D digital camera. All the samples were photographed at the same distance, with the camera fixed perpendicularly to the surface of the packaged rolls. To ensure even lighting, the samples were placed under an opaque shell, illuminated by indirect light on the outside. The images were transferred from the camera and stored as JPEG files.

2.2. Survey Questionnaire. Survey questionnaires in English, which was then translated into Mandarin, Japanese, and Korean by native speakers (these translations were then checked by two other native speakers), were developed around the images of the packaged sliced servings (Figure 2). To create the questionnaires, the selected images were imported into Corel Photo-Paint X7 V17.1, cropped to a uniform size, and laid out with the respective language questionnaires for printing. The images were not retouched or separately manipulated prior to layout for printing.

The questionnaire included demographic questions about the gender and age, frequency of consumption of hotpot, and the type of meat preferred for hotpot. Consumers were also asked to rank the 6 hotpots photos (from A to F) by preference, from the most preferred to the least preferred.

2.3. Population Surveyed. Members of the Chinese, Japanese, and Korean communities from all walks of life were surveyed, mainly from three New Zealand cities. The survey was carried out face to face at various settings including churches, clubs, campuses, and fairs where participants were directly approached and asked whether they would like to complete the questionnaire. We ensured that participants understood the questions and explained that they must concentrate on only the visible fat content in the photographs and not take any cues about meat quality from other attributes, such as number of slices, roll shape, or colour. Participation was completely optional, and respondents were not pressured or rewarded to respond before or after the survey.

A total of 115, 145, and 121 Chinese, Japanese, and Korean consumers, respectively, completed the questionnaires. Five of the Chinese and three of the Korean responses were discounted because respondents failed to rank the samples properly.

2.4. Image Analysis to Estimate Visible Fat Content. Evaluation of digital images of the hotpot slices was performed in Matlab 2014b (MathWorks) using the Image Processing Toolbox. Each image was initially cropped to reduce the viewing area of the images, and the meat was then manually delineated to create a mask (Figure 3(a)). This mask was multiplied with the cropped image to create a starting point for image processing and to reveal the total area of the meat in pixels. The colour image was converted to grayscale and then contrast adjusted to improve discrimination between fat and lean regions. An automatic threshold was then applied to convert the image to black and white, identifying fat as well as many small white regions that were not of interest. To remove this speckling effect, a filter was applied that morphologically opened (erosion followed by

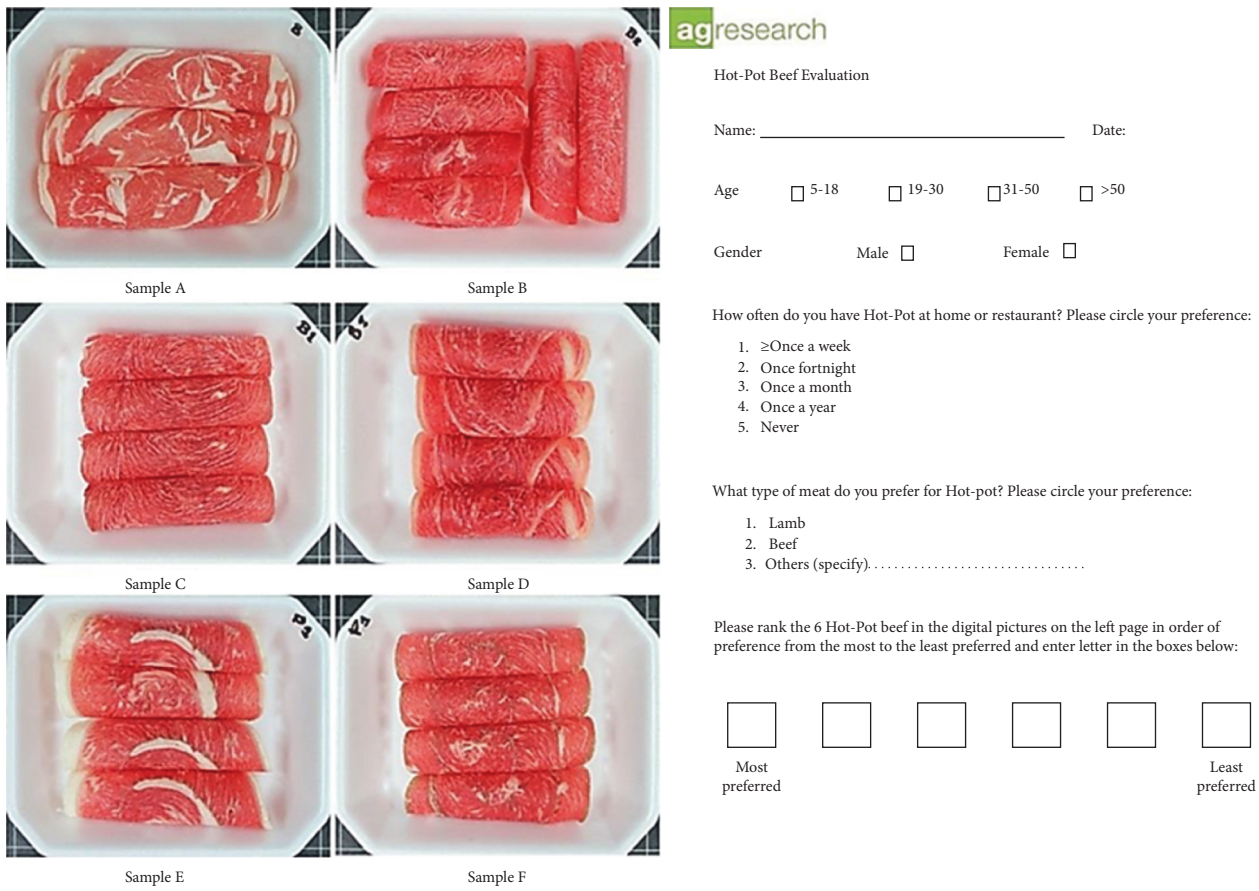


Figure 2: The English version of the questionnaire used in the survey of the three consumer groups.

dilation) the image using a disk-shaped structuring element with radius 4 pixels, followed by a close operation (dilation followed by erosion) with a larger disk-shaped structuring element having a radius of 6 pixels. The number of white pixels at this point represents the fat content in pixels and can be divided by the total pixel area found earlier to calculate the percentage of fat within the object. Following this, the perimeter of the white regions was identified and dilated to join up any gaps and overlaid onto the original cropped image to enable visual checking of the fat detection sensitivity (Figures 3(a) and 3(b)). Using this analysis (Figure 3(b)), the percent visible fat content of the hotpot samples was A (34.57), B (13.54), C (10.75), D (23.77), E (27.57), and F (14.81).

2.5. Statistical Analysis. The preference for the six hotpot beef samples for each person and ethnicity was given a ranked order, in which the most preferred sample was given a score of 6 and the least preferred was given a score of 1.A mixed-effects model was used to compare the responders' preferences. The full model included the fixed effects for ethnicity, age, gender, samples and their interactions. The random effect was the responder ID. There was a significant four-way interaction between sample, gender, age, and ethnicity ($P = 0.027$). Therefore, pairwise differences in the main effects within each ethnicity and two-way interactions using the standard error of differences from the full model were discussed. All analyses were performed in R [6] using "lmer" [7].

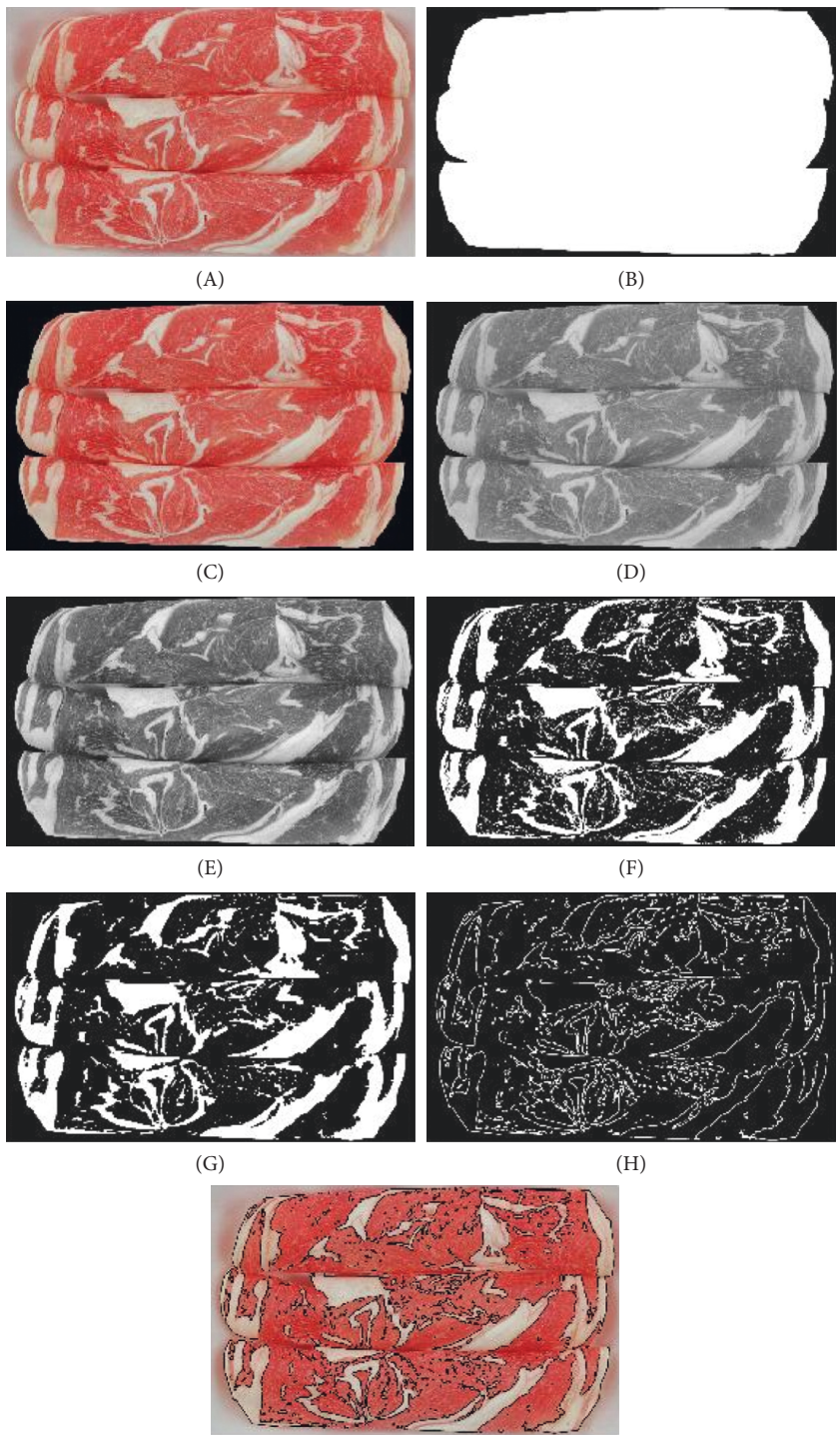
3. Results

3.1. Frequency of Hotpot Meat Consumption. Among the 110 Chinese consumers whose responses were analysed, none indicated that they consumed meat cooked in a hotpot every week, 6% reported that they consumed hotpot cooked meat once every fortnight, 30% once a month, 28% twice to 10 times a year, and 32% about once every year. 3% had never eaten hotpot cooked meat.

Of the Japanese consumers who responded to this question, no one consumed hotpot cooked meat every week, 2% had it fortnightly, 20% monthly, 46% about twice to 10 times a year, and 32% once a year.

None (0%) of the Korean consumers indicated they consumed meat cooked in hotpot every week (once a week), 20% of them consume hotpot cooked meat only once every fortnight, 48% once a month, and 31% about once every year.

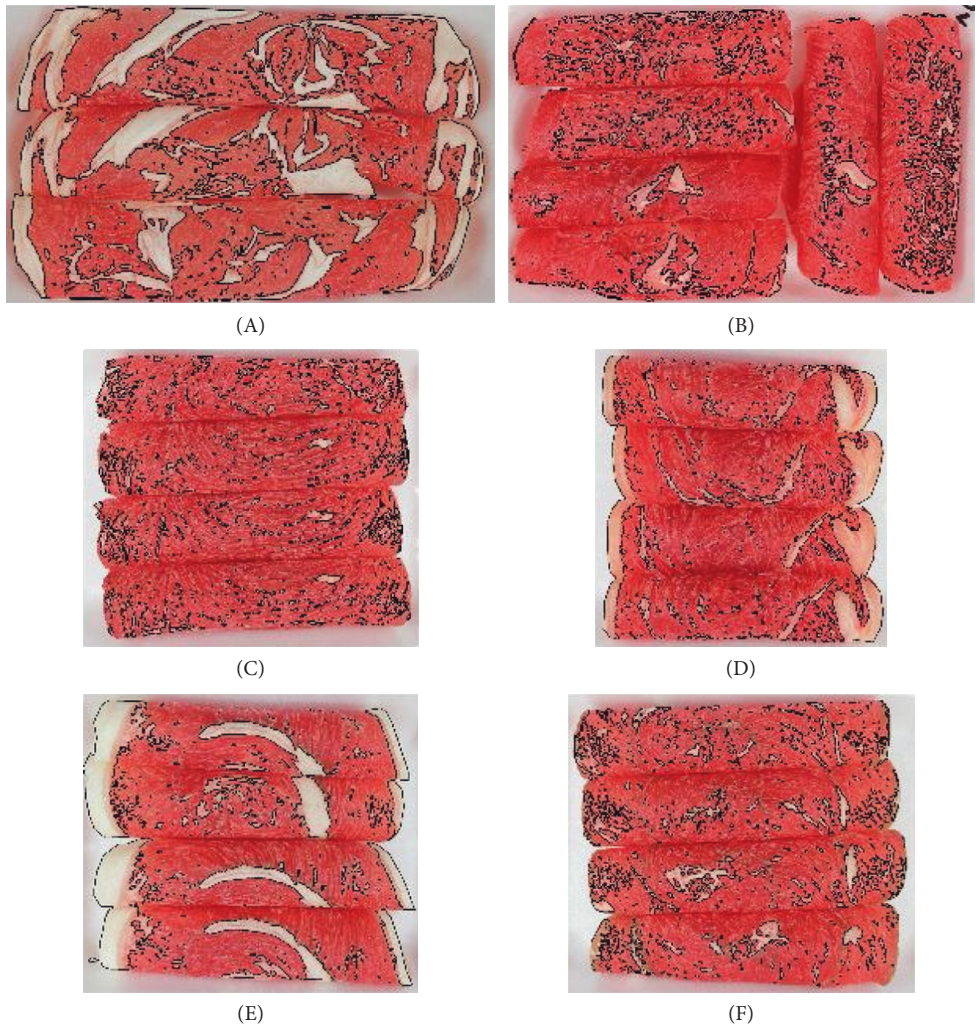
3.2. Hotpot Meat Type Preference. Among the NZ Chinese consumers surveyed, lamb/mutton was the most preferred meat for hotpot cooking (76%), followed by beef (14%) and



(A) (B) (C) (D) (E) (F) (G) (H) (I)

(a)

Figure 3: Continued.



(b)

Figure 3: (a) Images showing the processing steps for determining the percentage of visible fat within the samples: (A) cropped, (B) mask, (C) masked, (D) grayscale, (E) contrast adjusted, (F) B&W, (G) imopen and imclose, (H) identify perimeter, and (I) fat%: 34.57. (b) Images of the samples used in the survey and their percentages of visible fat: (A) 34.57, (B) 13.54, (C) 10.75, (D) 23.77, (E) 27.57, and (F) 14.81.

"others" (10%). Seafood, fish, vegetables, and tofu were included in the "others".

Fifty-five (55%) percent of the Japanese consumers preferred beef and 14% pork for hotpot. 10 and 9%, respectively, preferred a combination of beef and pork or beef and other meat. Only 2% preferred lamb and the remaining 10% preferred others.

Beef was the most preferred meat for hotpot cooking (86%) among the Korean consumers surveyed, followed by lamb/mutton (14%) and "others" included fish balls, pork, and chicken.

3.3. Visible Fat Content and Consumer Acceptability of Hotpot Meat. The representative images of the sliced hotpot meat for each of the six visible fat ranges used in the questionnaire are shown in Figure 3(b). Sample A had the highest percentage of visible fat at 35% and sample C had the lowest at 11%. There was a significant four-way interaction between samples, gender, age, and ethnicity for the preference of visible fat content of hotpot ($P = 0.027$). For this reason, the results for each ethnic group are discussed separately.

There were significant three-way interactions between samples, gender, and age ($P < 0.05$) and two-way interactions between samples and gender for the Chinese and Korean consumers, but not for the Japanese ($P > 0.05$). There were interactions between samples and age for all the three cultures ($P < 0.05$).

3.3.1. Chinese Consumers. Overall, NZ Chinese consumers preferred the sliced hotpot meat with the highest visible fat content while the rolls with the lowest visible fat content were the least favoured (Figure 4). The average rank given to sample A was 4.15, and this was significantly higher ($P < 0.05$) than the average ranks given to the other samples. When the individual preferences were separated into groups based on their choices of most preferred visible fat content,

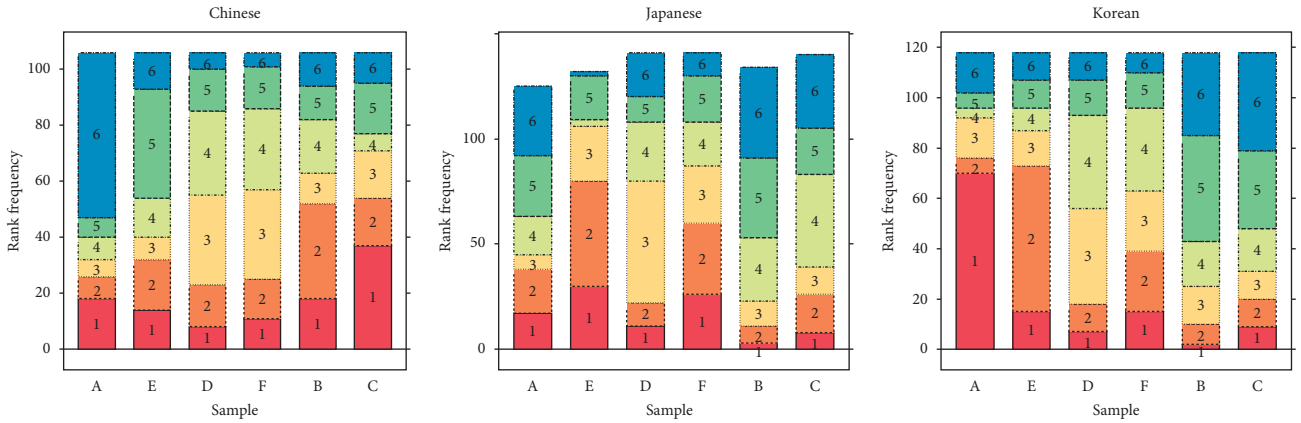


FIGURE 4: The frequencies of the rank for each sample, with the rank of 1 as the least preferred and 6 the most preferred. Samples are ordered from highest (A) to lowest (C) percentage of visible fat along the x-axis. A = 35%, E = 28%, D = 24%, F = 15%, B = 14%, and C = 11%.

the consumers that ranked sample A (35% visible fat content) as the most preferred also ranked sample C (11% visible fat content) as the least preferred and vice versa. This outcome strongly suggests that, overall, NZ Chinese consumers prefer fattier meats for their hotpot.

3.3.2. Japanese Consumers. Overall, regardless of gender or age, sample B (14% visible fat content) had the highest average rank of 4.2 and sample E (28% visible fat content) had the lowest of 2.33 (Figure 4), and this difference is significant ($P < 0.05$). Samples A and C also had high average ranks of 3.7 and 4.0, respectively, and there was no evidence that the average rank for sample B differs from that for samples A and C.

3.3.3. Korean Consumers. Korean consumers ranked sample A (35% fat) as the least preferred and sample C (11%) as most preferred overall (Figure 4), although similar number of people ranked the leaner looking samples B and C as the most preferred.

3.4. Influence of Consumer Gender on Hotpot Meat Visible Fat Acceptability

3.4.1. Chinese Consumers. Overall, the frequency of ranked samples was similar for both males and females (Figure 5). The difference in the average rank for the fattiest sample (A, 35% fat) did not significantly differ between males and females ($P > 0.05$) and the trend in ranking of the samples from least to most preferred was similar for both males and females. However, we noticed that more females than males indicated that the visibly fattiest sample (A) was their least preferred. Furthermore, more females than males indicated that the leanest sample (C, 11% fat) was their most preferred.

3.4.2. Japanese Consumers. The pattern in ranking appears similar for both males and females ($P > 0.05$). Slightly more females indicated sample A as their least preferred. Because there was no evidence of a statistical difference between males and females, these means are not discussed ($P > 0.05$).

3.4.3. Korean Consumers. The frequency of ranked samples was similar for both males and females (Figure 5). Slightly more females indicated sample A as their least preferred compared to males. Additionally, females indicated sample C was their most preferred compared to males who indicated sample B as their most preferred ($P < 0.05$). The trend in responders ranking of the samples from least preferred to most preferred was similar for both males and females.

3.5. Influence of Consumer Age on Hotpot Meat Visible Fat Acceptability

3.5.1. Different Ethnicities

(1) Chinese Consumers. The rank of the samples differed for older persons (50 years and older), the highest proportion of persons ranking sample A (35% fat) as the least preferred, with most in this age bracket ranking sample B (14% fat) as the most preferred. The average ranking for the fattiest sample (A, 35% fat) was 2.9 for older persons and this was significantly lower ($P < 0.05$) than the ranks of 4.8, 4.7, and 4.5 for the other age groups. Likewise, older persons gave the leanest sample (C, 11% fat) a higher average rank than the other age groups.

(2) Japanese Consumers. The number of persons ranking each of the samples was similar for the different age groups. For older persons (>50), there was a higher proportion ranking sample C (11% fat) as their most preferred.

(3) Korean Consumers. The 118 consumers surveyed were made up of 28% (19- to 30-year-olds), 30% (31- to 50-year-olds), and 42% (>50-year-olds). The average trend was similar for the different age categories (Tables 1–3). The rank

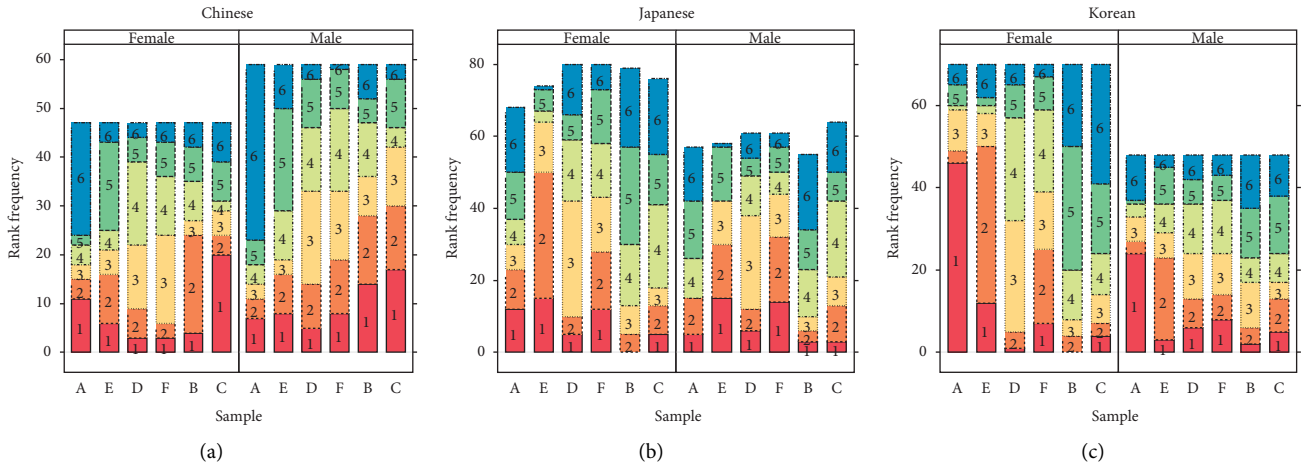


Figure 5: The frequency of ranking separated by gender, with the rank of 1 as the least preferred and 6 the most preferred. Samples are ordered from highest (A) to lowest (C) percentage of visible fat along the x-axis. A = 35%, E = 28%, D = 24%, F = 15%, B = 14%, and C = 11%.

Table 1: The Chinese, Japanese, and Korean mean preference (1 = least preferred; 6 = most preferred) of the samples for the age range of 19–30 years separated into females (F) and males (M).

Sample	Visible fat (%)	Sex	Ethnicity/mean preference		
			Chinese	Japanese	Korean
A	34.6	F	4.6	3.2	2.7
E	27.6	F	3.9	1.9	3.2
D	23.8	F	3.7	3.9	3.5
F	14.8	F	3.7	2.9	3.3
B	13.5	F	2.8	4.4	4.5
C	10.8	F	2.3	4.0	3.8
A	34.6	M	4.9	3.8	2.9
E	27.6	M	4.1	2.5	3.3
D	23.8	M	3.2	3.3	3.4
F	14.8	M	3.0	2.8	3.3
B	13.5	M	2.9	4.7	4.4
C	10.8	M	2.9	3.7	3.7
		SED	0.7	0.6	0.7
		Females (n)	18	12	20
		Males (n)	23	22	15

SED = standard error of difference between means within each ethnic group.

Table 2: The Chinese, Japanese, and Korean mean preference (1 = least preferred; 6 = most preferred) of the samples for the age range of 31–50 years separated into females (F) and males (M).

Sample	Visible fat (%)	Sex	Ethnicity/mean preference		
			Chinese	Japanese	Korean
A	34.6	F	3.9	3.2	1.4
E	27.6	F	3.7	2.5	2.5
D	23.8	F	3.5	3.3	3.7
F	14.8	F	3.3	3.3	3.4
B	13.5	F	3.3	3.7	5.0
C	10.8	F	3.2	4.3	5.0
A	34.6	M	5.2	5.0	2.8
E	27.6	M	4.4	2.8	3.3
D	23.8	M	3.6	2.8	3.4
F	14.8	M	3.0	4.2	3.6
B	13.5	M	2.7	3.8	2.7
C	10.8	M	2.2	2.8	2.2
		SED	0.6	1.2	0.7
		Females (n)	22	13	17
		Males (n)	26	18	18

SED = standard error of difference between means within each ethnic group.

of the samples did differ slightly for the age groups. Notably, the older persons (50 years and older) had the highest proportion of persons ranking sample C (the visibly leanest sample, 11% fat) as the most preferred. Younger persons (19–30) had equal numbers ranking sample A (the visibly fattiest sample, 35% fat) as the most preferred compared to the leanest sample C (11%).

3.5.2. Different Age Groups

(1) Age ≤ 18. Few younger persons under the age of 18 completed the survey. Among the Chinese consumers, females gave sample A (35% fat) the highest ranking (5.50) and sample C (11% fat) the lowest (1.50). In contrast, the average rank of males for sample A was 4.00 and for sample C was 4.60. Only 4 females and 5 males answered the survey in this age range, leading to very wide confidence intervals, and we cannot conclude if this difference between males and females was significant. There was evidence, however, to suggest that the change in rank from sample A compared to sample C for the females within this age category was significant ($P < 0.05$).

For the Japanese consumers, sample B had the highest mean rank of 4.8 in this age category; this was significantly ($P < 0.05$) higher than samples E, D, F, and C.

None of the Korean consumers who completed the survey were 18 years or younger.

(2) Age 19–30. The average rankings for hotpot visible fat content for responders aged 19–30 years are shown in Table 1.

Table 3: The Chinese, Japanese, and Korean mean preference (1 = least preferred; 6 = most preferred) of the samples for the age range of 50+ years separated into females (F) and males (M).

Sample	Visible fat (%)	Sex	Ethnicity/mean preference		
			Chinese	Japanese	Korean
A	34.6	F	2.0	4.2	2.0
E	27.6	F	1.6	1.5	2.2
D	23.8	F	3.0	3.6	3.9
F	14.8	F	4.2	3.0	3.0
B	13.5	F	5.0	4.4	4.9
C	10.8	F	5.2	4.3	5.1
A	34.6	M	3.2	3.2	2.5
E	27.6	M	2.3	2.6	2.9
D	23.8	M	2.8	3.8	3.6
F	14.8	M	4.7	3.0	3.3
B	13.5	M	4.7	3.2	4.7
C	10.8	M	3.3	5.2	3.3
		SED	1.3	1.1	0.6
		Females (n)	5	7	34
		Males (n)	7	5	16

SED = standard error of difference between means within each ethnic group.

Both the male and the female Chinese consumers in this age range ranked sample A higher than sample C. The mean ranks for sample A were 4.6 and 4.9 and those for sample C were 2.3 and 2.9 for females and males, respectively. There was no significant difference between the preferences of males and females in this age category ($P > 0.05$).

The Japanese consumer in this age range preferred sample B (14% fat) which had the highest mean rank of 4.6, and this was significantly higher than samples E, D, F, and C.

For Korean consumers, there was evidence that for both the males and females in this age range, sample A had a lower rank than sample B. The mean rank for sample A was 2.7 and 2.9 for females and males, respectively, and the mean rank for sample B was 4.5 and 4.4 for females and males, respectively. There was no evidence of a difference between males and females' preferences.

(3) Age 31–50. The average ranks for responders aged 30–50 are shown in Table 2. For the Chinese females, the average rank for sample A was 3.9, which was lower ($P < 0.05$) than the average rank for males (5.2). The average rank for sample C was 3.3 and 2.2 for females and males, respectively, showing no difference between males and females in their preferences for the leanest sample C. The difference in the ranking between A and C for the females in this age category was not significant but was for the males ($P < 0.05$).

Sample C had the highest mean rank of 4.1 among the Japanese consumers, and this was significantly higher than sample E ($P < 0.05$). For the Korean females in this age category, the average rank for the fattiest sample A was 1.4, which was lower than the average rank for males of 2.8. There was evidence that this difference was significant ($P < 0.05$). The average rank for samples B and C was 5 for females which was higher than the average rank of 3.8 and 4.2 for males for samples B and C, respectively. There was evidence that these differences are significant ($P < 0.05$). There was evidence that for females, the increase in ranking from sample A to sample C was significant ($P < 0.05$).

(4) Age over 50. The average ranks for responders aged over 50 years are provided in Table 3. The average rank of sample A for Chinese females was 2.0, which increased significantly to 5.2 for sample C. There was no significant difference in average ranking between samples A and C for the males ($P > 0.05$). The older Japanese consumers ranked the leanest sample C the highest (mean rank of 4.6), and this was significantly higher than samples E and F ($P < 0.05$). Sample E (28%) had the lowest mean rank of 1.9, which was significantly lower ($P < 0.05$) than samples A, D, B, and C.

The average rank of sample A for Korean females in this age category was 2.0 and this increased to an average rank for sample C of 5.1. There was evidence that this increase was significant ($P < 0.05$). The average rank for sample A for males was 2.5 and this increased to 4.8 for sample B. There was evidence that this increase was also significant ($P < 0.05$). There was no evidence of a difference between males and females for each sample.

4. Discussion

The conversion of beef farms to dairying in some of the major meat exporting countries is producing an abundance of bulls. Bulls are fast growing, and by 18 months old, they are ready for slaughter [8]. The meat from bulls is inherently leaner than that of steers, heifers, or cull cows. For export-oriented countries, process for adding value to this product category for both local and export markets is a highly regarded proposition. In the past, the focus was on how to deliver products to suit Western consumers in Europe. However, the focus is now shifting to Asia, particularly China, Indonesia, Japan, Korea, Malaysia, Thailand, and Vietnam where the volume of trade in meat is increasing [9–12]. Countries in this region such as Japan and Korea have strong preference for well-marbled beef [13, 14], and eating thinly sliced meat cooked in hotpots is popular in the region particularly in China where the tradition originated. This is why meat prepared for this form of cooking was chosen for the present study, for use in determining the acceptability of lean beef for hotpot. The aim was to understand the preference of consumers for hotpot meat in China, Japan, and Korea in terms of visible fat content at the point of purchase, an exercise that is imperative if the goal of exporting the right lean bull beef cuts to these countries for use as a hotpot were to succeed [15].

One of the hurdles we faced was how to get enough local Chinese, Japanese, and Korean consumers to assess the hotpot beef in the frozen rolled form that the product is normally sold, without running the risk of thawing and collapse, thereby losing its form and familiar characteristics. To circumvent this problem, we prepared the products and captured their digital images. These images were used for the consumer evaluation. The use of digital photographs instead of direct product samples to evaluate the visual acceptability of meat and other products has recently been validated

[16–18]. Passetti et al. [18] compared the outcomes of consumer visual acceptability of bull beef steaks directly in trays with sequential and random digital photos of the same and found that digital images could be used to evaluate beef colour. Furthermore, this method of evaluation resulted in more consistent outcomes compared to visualizing the steaks directly in trays. Holman et al. [19] also used standardised photographs of beef in a web-based survey to successfully determine the consumer acceptability of beef colour. The importance of visual estimation of fat content on the choice of beef has also been underscored by a recent study [20].

The results of the present study indicated that meat is consumed in hotpot about only once a month by about 36, 22, and 68 percent, respectively, of the New Zealand Chinese, Japanese, and Korean residents surveyed and that the majority of Chinese surveyed preferred lamb for hotpot cooking over beef which was most preferred by the Japanese and Koreans.

The preference of sheep meat for hotpot cooking over beef by the Chinese is most likely due to the long tradition in China of mutton hotpot consumption compared to beef. Wu et al. [1] reported that the consumption of mutton hotpot and instant-boiled mutton was influenced by the Chinese royal custom since the Qing Dynasty (1644–1912AD) and by the nomadic culture of the Mongols. Mao et al. [2] reported that hotpot is one of the top preferred cooking methods for sheep meat for both at home and away-from-home consumption in China. The Japan Livestock Products Export Promotion Council in its Wagyu promotional material traced the origin of *shabu-shabu*—a Japanese variant of hotpot—to the Chinese hotpot using mutton. The preference of mutton over beef for hotpot by the NZ Chinese is not a direct reflection of the level of consumption of the two meats in China. However, China's net import of mutton in 2012 was 119 thousand tons compared to 49 thousand tons of beef [10]; the per capita consumption of beef at home and away from home was higher than that of lamb/mutton inside China [21, 22]. It is probable that this reflects the overwhelming preference of lamb/mutton for hotpot cooking and is not indicative of overall meat type preference. This could be seen in the fact that pork—highly consumed in China—was hardly mentioned by the Chinese consumers surveyed in the list of the "others" meats for hotpot, since pork does not appear to be a traditional hotpot meat. Comparatively, the Japanese and Koreans mentioned pork among the meats preferred for hotpot, although their main preference for that type of cooking is beef. The higher preference of beef over sheep meat for hotpot cooking by the Japanese and Koreans could be due to their stronger culture of beef consumption compared to their Chinese counterparts [23].

Our results showed that, overall, the NZ Chinese surveyed preferred hotpot beef with the highest fat content and Koreans with the least and the Japanese in between (Figure 4). Those among the Chinese who preferred the highest visible fat content in hotpot also preferred the hotpot beef with the lowest fat content the least. The preference for high visible fat content could be due to the fact that across cultures, fat is often associated with good eating quality such as higher tenderness, juiciness, flavour, and satiety [13, 24–26]. It could also reflect the traditional use of mutton—a fattier meat—in hotpot by the Chinese compared to beef by Japanese and Koreans, leading to a higher fat content being specifically associated with positive hotpot eating quality. The specific association of fatness with hotpot may be true in the light of the fact that a recent study [5] found that fat is a dominant intrinsic meat quality cue for the Chinese consumer (explaining 78% of choice variance) and that consumers in China prefer leaner pork ribs compared to fattier ones, indicating that the preference for fattier meats could be specific to product types. Results of this study (Figure 5) indicate that although fattier hotpot meat was preferred overall by the Chinese consumers surveyed, more females than males ranked the fattiest hotpot beef sample (A) as their least preferred and the visibly leanest sample (C) as their most preferred, suggesting a gender difference in the preference for visible fat content of hotpot meat, with females preferring lesser fat in hotpot beef than their male counterparts. Previous studies have shown that consumer preference and perception of fat are affected by the gender of the consumer with females preferring less fatty foods than males [27, 28]. In an eye-tracking study comparing male and female consumers in Portugal, females were found to pay more attention to red meat and required less time to choose products with less fat content than men [20]. Wang et al. [29] analysed data of fatty and lean red meat consumption of 16,822 Chinese adults aged 18–75 years and found that males consumed more fat than women.

The average trend for the ranking of hotpot meat visual fat acceptance was generally similar for the age groups of the Chinese, Japanese, and Korean consumers surveyed (Tables 1–3). However, among older consumers (≥50 years), a higher proportion ranked sample A, with the highest visible fat content, as the least preferred. The older consumers in this study may have been more aware of and concerned about the health issues related to fat consumption than the younger ones [30]. Olsen [31] found health concerns related to seafood consumption among Norwegians to be higher in older persons compared to younger ones, whereas Russel and Cox [32] found that meat products were perceived in similar ways by the young, middle-aged, and older Australian consumers with only subtle differences between the age groups.

The findings of this study have some limitations and are preliminary. First, the consumer survey was carried out in New Zealand, although the main aim of the study was to determine consumers' acceptance of the visual fat content of hotpot beef, so that value can be added to lean bull beef through manipulation of the fat content of beef for export to Asian countries mainly China, Japan, and Korea. Thus, the results may not truly reflect the situation in those countries, and hence, the study would need to be repeated there. Secondly, the number of consumers from the three ethnicities surveyed was only 382, some of whom may be long-term residents of New Zealand, which could affect the information on their attitude and perception compared to the consumers' resident in their home countries. Furthermore,

the current study did not collect comprehensive demographic information on those surveyed in order to indicate how representative of their populations those surveyed were in terms of income, education, and frequency of meat consumption. However, this study has a number of strengths including (1) the novelty of the study, given we are not aware of any previous study of its kind in the published literature; (2) the outcomes provide a good understanding of the diaspora Chinese, Japanese, and Korean consumer attitude towards the visible fat content of beef which could be used by the meat industry in adding value to meat for consumers from these cultures residing in some of the red meat exporting countries; (3) the study also validated the use of digital images for consumer surveys and could specifically be adopted for use where meat products are difficult to evaluate due to attribute changes; (4) the role of females in food purchasing and preparation among the cultures and the increasing proportion of elderly in the population [33] should be considered when developing products for these countries in the light of the outcomes of the present study regarding the attitudes of these two demographic groups towards the visible fat content of meat; and (5) some of the interactions between age and gender found in the present study could be useful for designing dietary fat-related health policies and marketing strategies in countries with a sizeable population of Chinese, Japanese, and Koreans.

5. Conclusions

Hotpot is a widely acceptable format for eating meat among the Chinese, Japanese, and Koreans. The Chinese surveyed overall prefer fattier sliced hotpot beef compared to Koreans who preferred the leaner equivalents with the Japanese falling in between, with their males and the younger among them preferring more fat than the females and the elderly over 50 years old. The outcomes of this study have many implications for value adding to meat for the New Zealand Chinese, Japanese, and Korean consumers. It is also novel in the sense that it is the first of its kind to determine the effect of one of the most important consumer meat quality point of purchase cues—visible fat content—using the hotpot format of meat preparation and merchandising and using digital images rather than tangible products.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

Acknowledgments

This work was supported by governmental contestable funding pools (NZ Foundation for Research Science and Technology and NZ Ministry of Science and Innovation) and by the internal Strategic Science Investment Fund of AgResearch Limited (Contract A19113). The help of Robert Kemp with digital photography and layout is much appreciated.

References

[1] M. Wu, P. Guo, S. W. Tsui, H. Chen, and Z. Zhao, "An ethnobotanical survey of medicinal spices used in Chinese hotpot," *Food Research International*, vol. 48, no. 1, pp. 226–232, 2012.

[2] Y. Mao, D. L. Hopkins, Y. Zhang, and X. Luo, "Consumption patterns and consumer attitudes to beef and sheep meat in China," *American Journal of Food and Nutrition*, vol. 4, no. 2, pp. 30–39, 2016.

[3] L. Wang, "An investigation of Chinese immigrant consumer behaviour in Toronto, Canada," *Journal of Retailing and Consumer Services*, vol. 11, no. 5, pp. 307–320, 2004.

[4] C. Li, "A tale of two social networking sites: how the use of Facebook and Renren influences Chinese consumers' attitudes toward product packages with different cultural symbols," *Computers in Human Behavior*, vol. 32, pp. 162–170, 2014.

[5] K. G. Grunert, S. M. Loose, Y. Zhou, and S. Tinggaard, "Extrinsic and intrinsic quality cues in Chinese consumers' purchase of pork ribs," *Food Quality and Preference*, vol. 42, pp. 37–47, 2015.

[6] R Core Team, *R: A Language and Environment for Statistical Computing*, R Foundation for Statistical Computing, Vienna, Austria, 2013, http://www.R-project.org/.

[7] A. Kuznetsova, P. B. Brockhoff, and R. H. B. Christensen, "lmerTest package: tests in linear mixed effects models," *Journal of Statistical Software*, vol. 82, no. 13, pp. 1–26, 2017.

[8] G. Gleeson, "CH 2. Systems of beef production," in *Profitable Beef Production*, D. C. Smeaton, Ed., pp. 14–25, Meat New Zealand, Wellington, New Zealand, 2003.

[9] P. Sans and P. Combris, "World meat consumption patterns: an overview of the last fifty years (1961-2011)," *Meat Science*, vol. 109, pp. 106–111, 2015.

[10] Y. Wu-Sheng and C. Li-Juan, "China's meat and grain imports during 2000–2012 and beyond: a comparative perspective," *Journal of Integrative Agriculture*, vol. 14, no. 6, pp. 1101–1114, 2015.

[11] C. Ya-Hao, Z. Gao, and J. Searle Jr., "Changing structure of China's meat imports," *Journal of Integrative Agriculture*, vol. 14, no. 6, pp. 1081–1091, 2015.

[12] D. L. Ortega, S. J. Hong, H. H. Wang, and L. Wu, "Emerging markets for imported beef in China: results from a consumer choice experiment in Beijing," *Meat Science*, vol. 121, pp. 317–323, 2016.

[13] F. Iida, K. Saitou, T. Kawamura, S. Yamaguchi, and T. Nishimura, "Effect of fat content on sensory characteristics of marbled beef from Japanese Black steers," *Animal Science Journal*, vol. 86, no. 7, pp. 707–715, 2015.

[14] C. Jo, S. H. Cho, J. Chang, and K. C. Nam, "Keys to production and processing of Hanwoo beef: a perspective of tradition and science," *Animal Frontiers*, vol. 2, no. 4, pp. 32–38, 2012.

[15] R. J. Polkinghorne, T. Nishimura, K. E. Neath, and R. Watson, "A comparison of Japanese and Australian consumers' sensory perceptions of beef," *Animal Science Journal*, vol. 85, no. 1, pp. 69–74, 2014.

[16] S. M. Jervis, M. G. Jervis, B. Guthrie, and M. A. Drake, "The efficacy of using photographs to represent attributes of sliced sandwich bread in an adaptive choice-based conjoint," *Journal of Sensory Studies*, vol. 29, no. 1, pp. 64–73, 2014.

[17] C. Maughan, E. Chambers, and S. Godwin, "A procedure for validating the use of photographs as surrogates for samples in sensory measurement of appearance: an example with color of cooked Turkey patties," *Journal of Sensory Studies*, vol. 31, no. 6, pp. 507–513, 2016.

[18] R. A. C. Passetti, J. A. Torrecilhas, M. G. Ornaghi et al., "Validation of photographs usage to evaluate meat visual acceptability of young bulls finished in feedlot fed with or without essential oils," *Meat Science*, vol. 123, pp. 105–111, 2017.

[19] B. W. B. Holman, R. J. van de Ven, Y. Mao, C. E. O. Coombs, and D. L. Hopkins, "Using instrumental (CIE and reflectance) measures to predict consumers' acceptance of beef colour," *Meat Science*, vol. 127, pp. 57–62, 2017.

[20] M. Banović, P. Chrysochou, K. G. Grunert, P. J. Rosa, and P. Gamito, "The effect of fat content on visual attention and choice of red meat and differences across gender," *Food Quality and Preference*, vol. 52, pp. 42–51, 2016.

[21] Z. Zhou, W. Tian, J. Wang, H. Liu, and L. Cao, "Food Consumption Trends in China," Report Submitted to the Australian Government Department of Agriculture, Fisheries and Forestry, November 2016, http://www.agriculture.gov.au/SiteCollectionDocuments/agriculture-food/food/publications/food-consumption-trends-in-china/food-consumption-trends-in-china-v2.pdf.

[22] X. Hong-Bo, C. Qiong, W. Ji-Min, L. Oxley, and M. Heng-Yun, "The puzzle of the missing meat: food away from home and China's meat statistics," *Journal of Integrative Agriculture*, vol. 14, no. 6, pp. 1033–1044, 2015.

[23] K.-C. Nam, C. Jo, and M. Lee, "Meat products and consumption culture in the East," *Meat Science*, vol. 86, no. 1, pp. 95–102, 2010.

[24] E. C. Webb and H. A. O'Neill, "The animal fat paradox and meat quality," *Meat Science*, vol. 80, no. 1, pp. 28–36, 2008.

[25] J. D. Wood, M. Enser, A. V. Fisher et al., "Fat deposition, fatty acid composition and meat quality: a review," *Meat Science*, vol. 78, no. 4, pp. 343–358, 2008.

[26] C. R. Kerth and R. K. Miller, "Beef flavor: a review from chemistry to consumer," *Journal of the Science of Food and Agriculture*, vol. 95, no. 14, pp. 2783–2798, 2015.

[27] P. Käkkönen and H. Tuorila, "Consumer responses to reduced and regular fat content in different products: effects of gender, involvement and health concern," *Food Quality and Preference*, vol. 10, no. 2, pp. 83–91, 1999.

[28] E. Kubberød, Ø. Ueland, M. Rødbotten, F. Westad, and E. Risvik, "Gender specific preferences and attitudes towards meat," *Food Quality and Preference*, vol. 13, no. 5, pp. 285–294, 2002.

[29] Z. Wang, B. Zhang, F. Zhai et al., "Fatty and lean red meat consumption in China: differential association with Chinese abdominal obesity," *Nutrition, Metabolism and Cardiovascular Diseases*, vol. 24, no. 8, pp. 869–876, 2014.

[30] E. H. Zandstra, C. de Graaf, and W. A. Van Staveren, "Influence of health and taste attitudes on consumption of low- and high-fat foods," *Food Quality and Preference*, vol. 12, no. 1, pp. 75–82, 2001.

[31] S. O. Olsen, "Understanding the relationship between age and seafood consumption: the mediating role of attitude, health involvement and convenience," *Food Quality and Preference*, vol. 14, no. 3, pp. 199–209, 2003.

[32] C. G. Russell and D. N. Cox, "Understanding middle-aged consumers' perceptions of meat using repertory grid methodology," *Food Quality and Preference*, vol. 15, no. 4, pp. 317–329, 2004.

[33] M. Shi, B. Jun-Fei, J. Seale Jr., and T. Wahl, "Demographics, societal aging, and meat consumption in China," *Journal of Integrative Agriculture*, vol. 14, no. 6, pp. 995–1007, 2015.