American Journal of Food and Nutrition, 2016, Vol. 4, No. 2, 30-39
Available online at http://pubs.sciepub.com/ajfn/4/2/1

DOI:10.12691/ajfn-4-2-1

Consumption Patterns and Consumer Attitudes to Beef and Sheep Meat in China

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Abstract This review paper provides an overview of the meat production status in China and Chinese consumer requirements with respect to red meat, especially for beef and sheep meat. The analysis of meat output, consumption and price indicates that the production and consumption of beef and sheep meat has increased in China, and the price of meat has risen significantly as the consumption requirements have risen. The quantity and quality requirements of Chinese consumers in terms of beef and sheep meat are different between urban and rural residents and regions, and are influenced by price, income, religious beliefs, flavor, nutritional value, dietary habits, safety and eating quality. The demand for high quality and the concern with respect to the safety of beef and sheep meat by Chinese consumers is increasing, but there are gaps between the requirements and the supply, despite the increased the importation of beef and sheep meat. Lastly, the paper outlines what the meat industry and researchers should do to promote the strength of Chinese meat industry, and gives guidance to exporting countries with respect to the quality Chinese consumers are likely to expect in the future.

Keywords: *chinese consumer, quality requirements, influencing factors, cooking guidelines*

Cite This Article: Yanwei Mao, David L. Hopkins, Yimin. Zhang, and Xin Luo, "Consumption Patterns and Consumer Attitudes to Beef and Sheep Meat in China." *American Journal of Food and Nutrition*, vol. 4, no. 2 (2016): 30-39. doi: 10.12691/ajfn-4-2-1.

1. Introduction

As China's economy has developed rapidly, the process of industrialization and urbanization has accelerated and household income has increased, changing the meat consumption patterns of people and their attitudes to meat [1,2]. One of the most important changes is the increasing desire of Chinese to consume beef and sheep meat [2,3,4].

Chinese people domesticated cattle about 10,660 years ago [5], and domesticated sheep about 2000 years after that [6]. As such, cattle and sheep became two of the top six most important domestic animals in ancient China. Initially these species were used for sacrificial offerings, but over time their meat has increasingly been consumed by people. Consequently, such meats have become a favorite food of Chinese people [7].

As beef and sheep meat have become more popular in China, consumer attitudes to the quality of these meats has changed [2,3]. There has not however been a systematic and comprehensive review of Chinese meat production and consumption status, Chinese consumer attitudes and quality requirements for beef and sheep meat. On this basis a review of these topics has been undertaken to facilitate a better understanding of Chinese beef and sheep meat consumption trends and consumer's needs of these meats to ensure the rapidly expanding demand can be satisfied by the meat industry, and those countries that export red meat to China.

2. Beef and Sheep Meat Production and Consumption in China

In recent years, the production of meat has increased continuously in China and the regression of production vs. year is shown in Figure 1. Pig meat is produced in the largest quantity followed by poultry meat, beef and sheep and goat meat (Figure 1). Overall, meat production in China has increased by 43,780,000 tons from 1995 to 2014, which equates to 101.1% growth during this period. In 2014, pig meat, poultry meat, beef, goat and sheep meat production accounted for 65.1%, 20.1%, 7.9% and 4.9% of total meat production respectively. Over time the type of meat as a proportion of total meat production has changed with a reduction of pig meat from 68.7% in 1995 to 65.1% in 2014, and poultry meat, beef and sheep meat increased output from 12.8%, 2%, 6% in 1995 to 20.1%, 4.9% and 7.9% in 2014 respectively. Although the absolute production of these three types of meat is still low compared to pork, the growth rates of production for poultry meat, beef and sheep meat were 215%, 166% and 404% over the nineteen year period which was much higher than 91% for pig meat. As a consequence of the growth in beef production (Figure 1), China has become one of the five top beef production countries. Given that global beef production accounts for 21.8% of meat produced yet China produces only 7.9% of the beef

produced, China has scope to increase the production of beef meat if the growth over the period 1995-2014 can be continued (Figure 1). The predicted production of beef and sheep meat should reach 8,653,250 tons and 5,873,350 tons by 2025 (Figure 1) assuming a linear increase.

Despite the increases in domestic beef production, the quantity of beef and veal imported into China rose sharply from 29,000 tonnes in 2011 to 417,000 tonnes in 2014 [9]. However, compared to global figures, beef consumption per capita in China is low compared to that of the United States, Brazil and EU which in part reflects the large population in China. As a consequence China needs to produce and import more beef to meet the increasing demand of consumers.

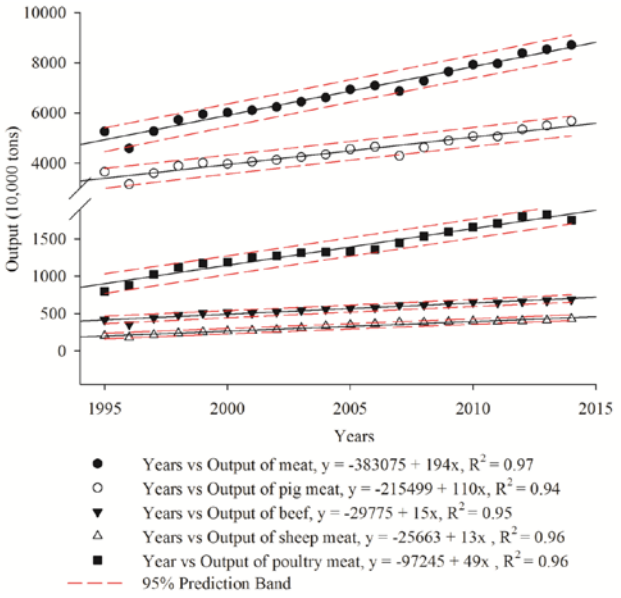

Figure 1. Meat production in China mainland. Note: The output data is from national bureau of statistics of the People's Republic of China

Sheep meat production increased from 1995 to 2014, although it is a small part of total meat production in China and the production growth has been stagnant since 2010 (just increased from 3,990,000 tons at 2010 to 4,280,000 tons at 2014). Thus the production increases have not been sufficient to cater for the increased demand for sheep meat. Consequently, imports have increased from 56,869 tons at 2010 to 254,335 at 2013 which increased by 347% [10]. Given the expectations that from 2015 to 2025, the consumption of sheep meat will keep increasing [3] a major issue for China will be balancing stagnant production with increasing demand. Thus in terms of sheep meat the trade deficit will increase [3,11] and it is expected that China will need to continue importing sheep meat in the future [3].

In line with the increased production of beef meat and increased importation of beef and sheep meat Chinese per capita consumption of these meats has increased steadily (Figure 2), but the largest increase has been in the consumption of pork and poultry amongst consumers. Urban consumers also have significantly higher consumption levels than rural consumers irrespective of the type of meat (Figure 2). Considering the low per capita meat consumption, there is scope for further growth in the consumption of all meats especially beef and sheep meat in China, as incomes increase [8].

With the surge in demand for beef and sheep meat, prices in China have increased by 390% for beef and 346% for sheep meat from 2000 to 2013, which was much greater than the price increase of pork (Figure 3). Given the current demand, it is predicted that the prices of beef and sheep meat will continue to rise to 89.6 and 99.0 Chinese yuan per kilogram at year 2025 (Figure 3).

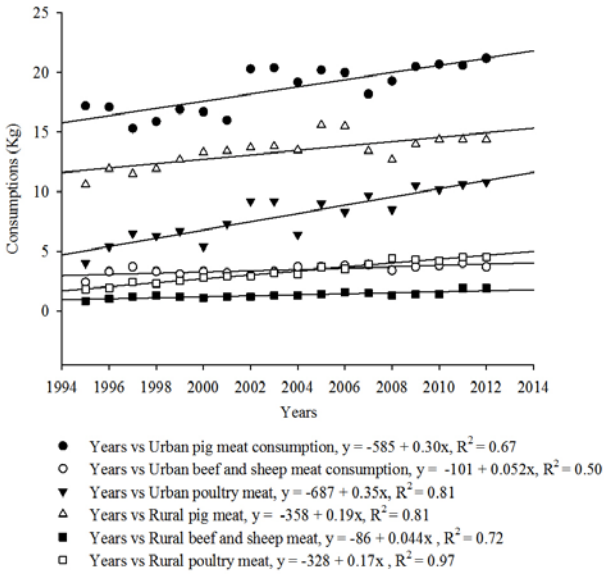

Figure 2. Per capita meat consumption in urban and rural China (Kg). Note: The consumption data is from national bureau of statistics of the People's Republic of China

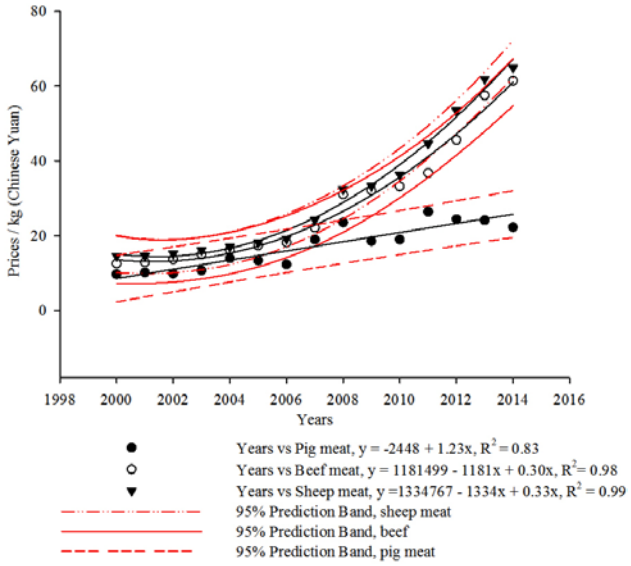

Figure 3. Price of pig meat, beef and sheep meat in China. Note: Price data is from the China year book of agricultural price survey

3. Characteristics of Beef and Sheep Meat Consumption in China

China is a large country with 56 ethnic groups, with disparity in household income between urban and rural, regions. These differences impact on the consumption patterns and levels resulting in urban-rural differences, regional differences and seasonal differences [12,13,14].

3.1. Different Consumption Habits for Beef and Sheep Meat between Urban and Rural Consumers

In total, not only are there different meat consumption levels between urban and rural consumers across species (Figure 3), but they also vary between regions. In Shanxi province, meat consumption consists of 50% pork, 28% poultry, 12% beef and 10% sheep meat in urban areas, and 87% pork, 8% poultry, 3.5% sheep meat and 1.5% beef in rural areas [15]. By contrast in Xinjiang Uygur Autonomous Region (north-west of China), meat consumption consists of 40% sheep meat, 17% pork, 15% poultry, and 16% beef in urban areas, and 55% sheep meat, about 20% beef, 17% poultry and 4% pork in rural areas [15]. In this region sheep meat consumption is high because Muslims account for 59.8% of the population [12]. This suggests that as urbanization in China continues beef and sheep meat consumption will increase, but this will be affected by regional economics and the religious beliefs of residents [15,16].

The average per capita consumption by urban residents' of beef and sheep meat was 3.7kg in 2012, which was double the level of rural residents and this was similar to the level for poultry (Figure 3), however there was a smaller absolute gap for pork consumption. Although beef and sheep meat consumption amongst rural consumers increased by 35.7% between 2010 and 2012, most research has proposed that the gap between urban and rural residents in per capita consumption will get larger in the future [12,13,17].

3.2. Regional Differences in Red Meat Production and Consumption

The different environments and resources available in the regions have led to different animal husbandry practices across China, and the production areas are developing and changing with different local agricultural policies across China. Economic development in China is region-specific, and different income levels lead to different levels of meat consumption between regions. The outputs and prices of meat were compared between different regions on the China mainland (Table 1 and Table 2). The results showed that not only the total meat output, but the output of different varieties of meat were all significantly different between the regions (Table 1). The results showed that the prices were also significantly different between regions. The beef prices vary from 52.1 Yuan/kg at Qinghai to 84.3/kg Yuan at Fujian. The sheep meat prices vary from 46.1Yuan/kg at Shaanxi to 78.6 Yuan/kg at Hainan.

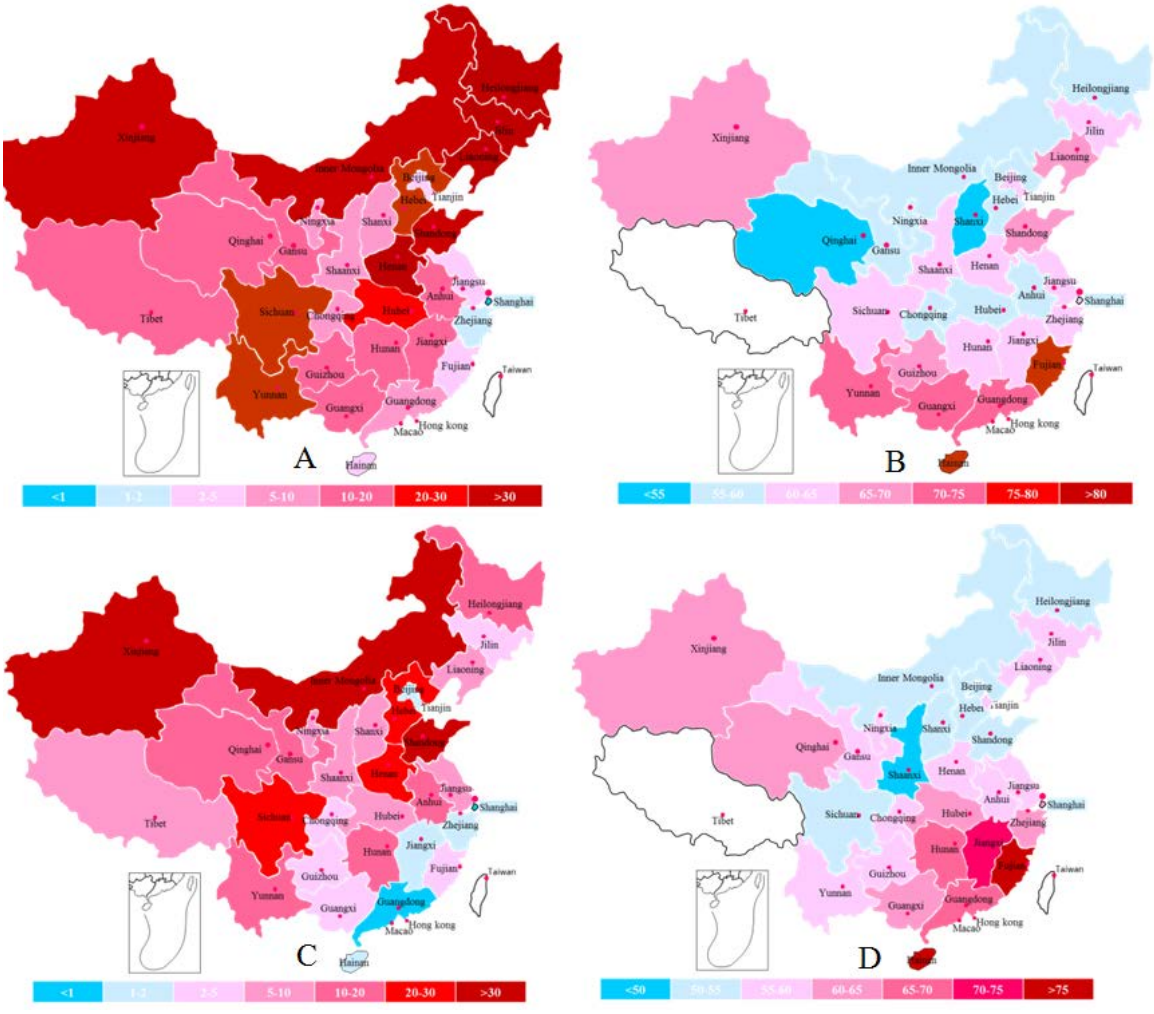

Figure 4. Output and price of beef and sheep meat in different regions of China mainland. Note: A = output beef, B = price of beef, C = output of sheep meat and D = price of sheep meat. Output data is from national bureau of statistics of the People's Republic of China. Price is from the China year book of agricultural price survey. The unit of the colour symbol bars is ten thousand tons in output and Chinese Yuan in price. The price in Tibet is not available and shown in white. The sketch maps are drawn to show the output of beef and sheep meats in China are not to scale

Table 1. Meat production of different provinces in China mainland (10,000 tons)

Provinces	Total meat	Pig meat	Sheep meat	Beef meat
Beijing	41.4^{a}	24.2b^{cd}	1.2^{abc}	2.0^{ab}
Tianjin	46.2^{a}	29.6^{cde}	1.5^{abcd}	3.3^{bc}
Hebei	453.3^{n}	268.5^{nop}	29.4^{p}	53.3^{o}
Shanxi	82.7^{b}	60.6^{fg}	6.3^{fg}	5.3^{cd}
Inner Mongolia	247.7^{gh}	73.5^{gh}	90.3^{r}	52.5^{o}
Liaoning	422.7^{lm}	234.7^{lm}	8.3^{ghi}	43.1^{n}
Jilin	261.5^{h}	136.5^{i}	4.3^{ef}	45.3^{n}
Heilongjiang	222.6^{fg}	134.8^{i}	11.9^{kl}	40.0^{n}
Shanghai	24.3^{a}	18.6^{abc}	0.6^{a}	0.02^{a}
Jiangsu	386.4^{jk}	230.4^{l}	7.8^{gh}	3.3^{bc}
Zhejiang	170.7^{e}	135.2^{i}	1.7^{abcd}	1.2^{ab}
Anhui	405.2^{kl}	256.0^{mno}	15.0^{mn}	18.1^{jk}
Fujian	208.6^{f}	154.8^{ik}	2.1^{abcde}	2.6^{b}
Jiangxi	324.3^{i}	247.4^{lmn}	1.1^{abc}	12.6^{g}
Shandong	769.7^{q}	392.1^{r}	34.3^{p}	67.2^{p}
Henan	698.5^{p}	454.9^{s}	25.0^{o}	81.0^{q}
Hubei	427.6^{lmn}	329.2^{q}	8.3^{ghi}	20.3^{k}
Hunan	527.0^{o}	438.8^{s}	10.7^{jk}	18.0^{ij}
Guangdong	436.0^{mn}	278.9^{p}	0.9^{bc}	6.9^{de}
Guangxi	417.0^{lm}	260.0^{nop}	3.2^{cde}	14.2^{gh}
Hainan	80.6^{b}	49.1^{ef}	1.1^{abc}	2.6^{b}
Chongqing	207.8^{f}	154.7^{ik}	3.1^{bcde}	7.7^{e}
Sichuan	691.8^{p}	511.5^{t}	24.6^{o}	31.^{2l}
Guizhou	197.3^{f}	161.8^{k}	3.6^{de}	14.0^{gh}
Yunnan	362.2^{j}	277.5^{op}	14.0^{lm}	32.4^{l}
Tibet	26.1^{a}	1.5^{a}	8.3^{ghi}	15.7^{hi}
Shaanxi	112.1^{c}	87.9^{h}	7.1^{gh}	7.6^{de}
Gansu	91.4^{bc}	50.7^{ef}	16.8^{n}	17.3^{ij}
Qinghai	31.9^{a}	10.0^{abc}	10.6^{ijk}	10.2^{f}
Ningxia	27.5^{a}	7.5^{ab}	9.0^{hij}	8.5^{ef}
Xinjiang	141.0^{d}	31.8^{de}	50.4^{q}	37.7^{n}
SE	4.7	3.9	0.4	0.4

Note: The output of meat is based on means from 2010 to 2014. The means with different letters are significantly different at the 0.05 level (P < 0.05) within columns. The Multiple Comparisons are based on the Tukey HSD.

The output and price of beef and sheep meat were fitted to the map of the China mainland to show the regional differences directly and vividly (Figure 4). The maps indicate that north east China, Xinjang, Inner Mongolia, Shandong, Hebei, Henan, Sichuan and Yuan produced the most beef. Xinjang, Inner Mongolia and Shandong produced the most sheep meat, and then followed by Henan, Hebei and Sichuan. Xinjang, Inner Mongolia, Shandong, Sichuan, Henan and Hebei are all produced lots of both beef and sheep meat. But Heilongjiang, Jilin and Liaoning in north east China and Yunan just produced lots of beef but much less sheep meat. The farming areas (such as Shandong, Henan, Hebei and Sichuan province) produce more sheep meat than pastoral areas (such as Inner Mongolia Autonomous Region and the Xinjiang Uygur Autonomous Region) and have become the major sheep production regions, but the western pastoral areas are still very important. In basically, the regions which produced more beef and sheep meat the prices are lower. North China and north east China had low beef and sheep meat prices, but the south east China province of Fujian had the highest beef and sheep meat prices. Xinjiang produced lots of beef and sheep meat, but had a middle price for beef and sheep meat. This might be because Xinjiang has the ethnic groups that like beef and sheep meat and has a rigid requirements on these meats.

Table 2. Meat prices of different provinces in China mainland (Chinese Yuan / kg)

	Pig meat	Beef	Sheep meat
Beijing	22.8^{bcdefg}	61.5^{abcdefg}	54.0^{abcd}
Tianjin	23.3^{cdefgh}	60.5^{abcdef}	55.8^{bcde}
Hebei	22.0^{abcd}	59.8^{abcdef}	53.1^{abc}
Shanxi	21.9^{abcd}	54.7^{ab}	53.4^{abcd}
Inner Mongolia	21.2^{abc}	55.4^{abc}	52.8^{abc}
Liaoning	23.2^{cdefgh}	69.1^{fghi}	57.0^{bcdef}
Jilin	19.9^{ab}	63.5^{bcdefgh}	55.5^{bcde}
Heilongjiang	22.3^{abcde}	57.3^{abcde}	50.8^{ab}
Shanghai	26.7^{ij}	64.5^{cdefgh}	62.8^{efgh}
Jiangsu	23.1^{cdefgh}	61.4^{abcdefg}	58.8^{bcdef}
Zhejiang	24.8 ^{defghi}	63.4^{bcdefgh}	69.2 ^{hij}
Anhui	23.8^{cdefghi}	58.7^{abcde}	57.6^{bcdef}
Fujian	19.4^{a}	84.3^{j}	77.2^{jk}
Jiangxi	23.0^{cdefgh}	60.9^{abcdef}	75.0^{ijk}
Shandong	22.4^{abcdef}	65.6^{defgh}	53.5^{abcd}
Henan	22.6^{bcdef}	64.2^{bcdefgh}	56.0^{bcde}
Hubei	25.1^{efghi}	56.1^{abcd}	63.0^{efgh}
Hunan	23.8^{cdefghi}	63.2^{bcdefgh}	67.6^{ghi}
Guangdong	23.6^{cdefgh}	75.6^{ij}	69.0^{hij}
Guangxi	21.9^{abcd}	71.8^{hi}	64.4^{efgh}
Hainan	29.2^{j}	84.0^{j}	78.6^{k}
Chongqing	22.5^{bcdef}	57.4^{abcde}	59.5^{fgh}
Sichuan	23.2^{cdefgh}	61.3^{abcdef}	54.8^{bcde}
Guizhou	25.4^{fghi}	65.4^{defgh}	58.6^{bcdef}
Yunnan	25.8^{ghi}	71.0^{ghi}	59.7^{cdefg}
Tibet	NA	NA	NA
Shaanxi	23.5^{cdefgh}	63.5^{bcdefgh}	46.1^{a}
Gansu	23.4^{cdefgh}	55.6^{abc}	56.5^{bcdef}
Qinghai	24.4^{defghi}	52.1^{a}	60.3^{cdefg}
Ningxia	24.6^{defghi}	56.9^{abcde}	56.7^{bcdef}
Xinjiang	26.0^{hi}	65.8^{efgh}	61.4^{defgh}
SE	0.52	1.65	1.42

Note: Prices are means for 2013 and 2014 from the China year book of agricultural price survey. NA = not available. The means with different letters are significantly different at the 0.05 level (P < 0.05). The Multiple Comparisons used Tukey HSD.

Residents in south China consumed more meat per capita than residents in north China, which is a direct reflection of the better economic situation in southern China [18]. However, residents from northern China consumed double the quantity of beef meat of residents in southern China due to their consumption habits and the availability of beef [18]. For example, most ethnic groups that like beef and sheep meat live in the west and north-west of China (e.g Xinjiang Uygur Autonomous Region), and these different preferences also result in different varieties of meat being consumed between regions. Residents in western China consume the most beef, followed by eastern, northeastern, and central China [12]. So economics, religious beliefs, environmental concerns, dietary habits, and price all lead to regional differences in beef and sheep meat consumption in China [19,20].

3.3. Seasons affect Beef and Sheep Meat Consumption

In traditional Chinese medicine, beef and especially sheep meat are considered to be kinds of warm or hot food, and it is considered healthy to consume beef and sheep meat in cold weather.

Ninety-five percent (95%) of households which like to buy beef in winter, seldom buy beef in the summer [19]. Of sheep meat consumers who do show a seasonal

preference 94.9% prefer to eat this meat in the winter while 21.7%, 9.7% and 8.6% prefer to eat it in autumn, spring, and summer, respectively [21]. Interestingly 12.3% of urban consumers like to eat sheep meat in the summer, compared with just 1.6% amongst rural consumers and this due to the increasing popularity of the kebab in urban areas increasing consumption during summer [21]. The meat prices were compared between different months (Table 3). The price of pig meat was different between months and without a regular pattern. This might be a reflection of price fluctuating with supply. The price of beef did show a significant difference between months and increased with time from January to December. This might be a reflection of price increasing with time. The sheep meat price showed no significant difference between months. Overall, this suggests that seasonal differences are declining as hot pot and kebab's become popular in China, consequently changing the consumption of sheep meat from being winter dominated to all year around [3,16].

Table 3. Meat prices of different months in China mainland (Chinese Yuan / kg)

Months	January	February	March	April	May	June	July	August	September	October	November	December	SE
Beef	52.9^{a}	53.3^{a}	53.2^{a}	53.4^{ab}	53.8^{ab}	54.3^{ab}	54.6^{ab}	55.0^{ab}	55.7^{ab}	56.4^{ab}	57.1 ^{ab}	58.2^{b}	.934
Pig meat	26.0^{a}	24.9^{ab}	23.3^{abc}	21.7^{c}	22.2^{bc}	22.5^{bc}	22.8^{bc}	23.8^{abc}	24.1^{abc}	24.0^{abc}	24.0^{abc}	24.3^{abc}	.61
Sheep meat	59.1	59.4	58.9	59.0	59.3	59.6	59.9	60.1	60.6	61.0	61.4	62.2	0.79

Note: Prices are means from 2012 to 2014 from the China year book of agricultural price survey. The means with different letters are significantly different at the 0.05 level ($P < 0.05$). Means without letter means are not significantly different ($P > 0.05$). The Multiple Comparisons used Tukey HSD.

4. Attitude of Consumer to Beef and Sheep Meat Consumption and Influencing Factors in China

4.1. Why Eat Beef and Sheep Meat?

Chinese people traditionally eat high levels of pork (Figure 2) compared to red meats, but as revealed by research there have been increases in the consumption level of beef and sheep meat. Of beef consumers, 41.8% eat beef because they like the beef flavour, 30.9% eat beef due to dietary habits and 18.2% eat beef for nutritional reasons. Of consumers who do not like beef 68% attribute this to the beef flavour and 18% because they find cooking beef difficult [19]. A survey indicated that 54% of residents like beef in northern China because they like beef flavor [22]. But diversifying food consumption is the main reason to eat beef in southern China, and in that region about 30% of consumers like beef because of the beef flavour [18]. Of the residents who live in Hefei and Zhengzhou 69% like beef, while 54% of residents like beef in Beijing and 38% like beef in Shanghai [18]. The reasons that residents in Hefei and Zhengzhou rate beef highly is that they like beef flavor, whereas Shanghai consumers buy beef to add food diversity, and Beijing consumers buy beef because they consider beef a healthy food [18,22].

A study of 16 provinces in eastern, central, and western China indicated that 79.7% of urban residents and 82.7% of rural residents like sheep meat, and 12% of urban residents and 8.7% of rural residents do not like sheep meat [3]. The main reason that they like sheep meat is because of the nutritional value of the meat (52.9% and 44.9% of urban and rural residents, respectively). Other reasons given for eating sheep meat include liking the flavour, diversification in meat intake and because it is a food traditionally eaten. Furthermore, urban residents like sheep meat as they consider it a safe food [3]. Even though some Chinese like the flavour of sheep meat (41.7%) a greater number do not like the flavour (57.3%) as indicated by survey [14].

By contrast with some other provinces (e.g. Xinjiang Uygur Autonomous Region) a survey of meat consumption in Hebei province showed that residents like pork very much, but not beef or sheep meat. In this survey, 69.6% of the population liked pork, 15.6% liked beef, 13.3% liked sheep meat, and 21.5% liked poultry. Forty percent (40.10%) of the residents made the decision about which meat to purchase based on dietary habits, however residents also based decisions on flavour (24.8%), nutritional value (18.8%) and ease of cooking (12.4%) [8].

4.2. How to Eat

4.2.1. Cooking Method

In the past most beef was consumed as sauced beef or in the dumpling style, but this is changing with an increase in the amount consumed as hot pot or steak [18]. In China the top three cooking methods for sheep meat are stewing, cooking in a hot pot or roasting. Of urban residents 59.1% like stewed and 50.8% liked hot pot cooked sheep meat when consumed at home, and for rural residents the values are 60.5% and 37.3% respectively [21]. Of urban and rural residents 39.9% and 26.0% like stewed or hot pot cooked sheep meat when consuming away from the home. Roasted sheep meat is consumed by 47.7% of urban and 35.1% of rural residents when away from the home [21]. Other research suggested that 64.8% of residents will select stewed sheep meat, 34.6% will select in a hot pot and 19.1% will select roasted sheep meat when consuming sheep meat [14].

4.2.2. Away-from-home Consumption

The food consumption patterns of Chinese consumers are in a state of transition. Diet composition is shifting from being dominated by vegetables to a vegetable and animal balanced diet, and the consumption pattern is diversifying from home cooking to consumption away from the home [23]. Away from home consumption now accounts for a large proportion of meat consumption (Table 4). More beef and sheep meat is now consumed away from home exceeding pork and poultry consumption in urban areas. By contrast rural consumers have a more even consumption level for beef, sheep and poultry meat, with lower levels of pork consumption (Table 4). Urban residents consume more meat away from home reflecting their higher income. The away from home consumption of urban and rural residents is growing, and the countryside has great growth potential because rural residents have

lower away from home consumption compared to urban residents, but their incomes are rising quickly [14].

Table 4. Percentage of the main meats consumed away from home in China (%) according to place of residence

Meat type	Urban residents	Rural residents
Sheep	39.9	26.0
Beef	32.6	27.2
Pork	25.4	16.0
Poultry	31.6	27.8

Note: Data from Ding (2014). Percentage data accounts for the total quantity of each meat type.

Other research [17] proposed that Chinese urban residents consume about half their beef away from the home which was a higher proportion than that reported by Ding (2014) as shown in Table 4. Furthermore, out of home beef consumption will increase with rising incomes, in China which will promote beef consumption especially prime beef in the future [24]. Consumers aged 40-49 consume more sheep meat away from home than those of other age categories because they have higher consuming ability and more social activities [25]. Those who are well educated and have higher incomes consume sheep meat more often [25]. For example families that have an average income more than 6001 Yuan per month consume more than 78.0% of their sheep meat away from the home [25].

Away from home consumption of sheep meat also varies across areas. Urban residents living in eastern China consume sheep meat away from the home on 48.0% of occasions, while rural residents consume sheep meat away from home on 34.0% of occasions. A similar trend is found for the central and western regions of China, where urban residents eat sheep meat away from home on 36.0% and 37.0% of occasions while rural residents do so on 35.0% and 19.0% of occasions [3] indicating that overall, residents from eastern China consume the most sheep meat away from the home [3].

4.3. Factors Influencing Beef and Sheep Meat Consumption

Beef and sheep meat consumption is affected by many factors, such as price, income, nutritional value, flavor, dietary habits, safety, eating quality, the convenience of purchase [3,12,14,16,26], and even weekends and holidays. For example a survey indicated that half of the consumers of sheep meat do this on weekends and holidays [14].

4.3.1. Meat price and Income

Price and income are key factors affecting beef and sheep meat consumption [12,27]. This is creating larger differences in consumption levels between people [4]. Consequently, beef consumption of urban residents is affected by income, and considering the average income is still in the middle or lower zone, beef consumption has great potential to increase as the economy undergoes further development. By contrast it is suggested that for rural residents, beef consumption is affected by the price of beef, and so these residents have a low demand for costly food [4,17]. The net income per rural resident and the price of beef and pork affects beef consumption significantly, and consequently beef consumption by rural residents is more sensitive to income [12].

Li (2016) analyzed the effects of income, the price of beef and some other substitute protein foods such as sheep meat, pork and eggs on the consumption of beef in China [19]. The results indicated that income and the price of beef affect beef consumption in north and south China, but income does not affect beef consumption significantly in west China, as residents in west China consumed beef and sheep meat for religious reasons [19].

It is predicted that sheep meat consumption will increase as incomes rise and the attitude of Chinese to sheep meat changes [16,18]. Those whose income is above average consume the most sheep meat considering it a nutritious and healthy food, but those who have the highest income will consume less sheep meat as a proportion of their diet as they can afford other kinds of food [16]. There is a turning point for meat consumption and the level of income [28]. Lv (2012) analyzed the factors influencing sheep meat consumption in China with the exception of Xinjiang, Tibet, Qinghai provinces and Ningxia autonomous region because the residents who live there consume sheep meat for religious reasons [16]. This overrides other considerations and so in Xinjiang for example the price of sheep meat, beef and poultry and the season, had no effect on sheep meat consumption [26]. In other urban areas of China income level, the price of sheep meat, beef and pork influence the level of sheep meat consumption. For rural residents the price of sheep meat and the quantity of sheep meat consumed in the previous year (the quantity of food consumed in the previous year is considered to be a dietary habit that can affect meat consumption in China) are the key factors which influence consumption levels [16]. Although the level of sheep meat consumption in China has increased, there is still a huge gap compared to developed countries and big differences between different income levels and different regions in urban and rural areas [16].

The increasing cost of feeding sheep, the strong demand for sheep meat and the stagnant growth of sheep numbers for slaughter due to grazing prohibitions has all contributed to an increase in the price of sheep meat. Based on this it is expected that the price will keep rising [3,29], which may lead to a drop in consumption particularly amongst rural residents, especially those from southern China [30]. The rise in the price of sheep meat since 2000, has been fueled by no increase in supply because of state run prairie policies which were designed to prevent overgrazing. This protection system achieved remarkable results, but also had a short-term impact on lamb supply and along with prairie disasters, especially sudden natural disasters, had a substantial impact on the sheep industry [31].

4.3.2. Buying Behavior of Beef and Sheep Meat

Most consumers buy beef from farmers markets and supermarkets, and education, age, gender and marriage status influence where beef is purchased, and as the level of education increases consumers are more likely to buy meat from a supermarket [2]. About 20%, 44% and 15% of urban residents like to buy beef and sheep meat in specialized retail shops, supermarkets or farmers markets respectively. For rural residents 36% prefer to purchase their beef and sheep meat at a countryside market, 35% at a specialized retail shops and 18% at a town market [8].

The convenience of meat purchase will accelerate meat consumption [1]. About 12% of residents who live in rural areas believe it is not convenient to buy raw beef, and 38% of all respondents would increase beef consumption if they could buy beef conveniently and in stores that are attractive and modern. By contrast amongst urban residents 5% think buying raw beef is not convenient, and only 28% of all respondents would increase their consumption level if they could buy beef conveniently and in stores that are attractive and modern [19].

The product form and packaging also affect consumer purchasing behavior. Of consumers 37.4% like sheep meat cut according to anatomical locations, 24.7% like sheep meat slices, 21.4% like to buy cooked sheep meat, and 16.9% of consumers like lamb slices. In terms of packaging, 60.7% of consumers like to purchase sheep meat in bulk, and 23.5% like to buy sheep meat in packs of specific weight and combinations of cuts [14].

4.3.3. Safety

Chinese consumers are concerned about the safety of beef and sheep meat, but they have poor ability to differentiate on meat quality [2,3,14,32]. Of Chinese consumers 76.1% do not know how to identify eating quality or the safety of sheep meat [14]. In order to promote food safety in China, the Chinese government established pollution-free food, Chinese green food and organic food standards with the requirements becoming stricter for each standard with organic the most strict. Food must be produced according to the standards and certified after inspection which allows specific logos to be used. A survey indicated that only 38.5% of consumers can differentiate the pollution-free food, Chinese green food and organic food correctly [2]. These consumers pay close attention to beef safety based on information from television, newspapers and the internet. Most consumers can only judge beef meat safety from color and appearance of freshness [2] and a large percentage would pay more money to buy beef with a guaranteed safety (Table 5). It is apparent that consumers will pay more for branded beef (beef produced by Chinese beef processing companies, not from Halal family slaughter houses) and beef that is classed as either “pollution-free”, “green food” or “organic” and that 10% is the upper level to which consumers are prepared to pay more across the different categories, but this will increase if the food is labelled as “green or organic”.

Table 5. The percentage of consumers who would pay more money for safe beef in China according to the source of beef

The increase in the level of money consumers are prepared to pay for specific types of beef	The percentage of consumers who would pay more (%)			
	Branded beef	Non-pollution beef	Green beef	Organic beef
0-5%	41.6	54	31.2	25.6
6-10%	48.3	37.6	45.7	40.4
11-20%	4.3	4.8	16.4	14.3
21-50%	2.7	3.0	4.8	13.5
>51%	3.2	0.5	1.9	3.2

Data from Li (2012). Branded beef refers to beef produced by Chinese beef processing companies, not from Halal family slaughter houses; Non-pollution beef, Green beef and Organic beef are produced according to specified food production and processing standards and certified by management organizations.

Of urban residents 95.6% are concerned about the freshness of sheep meat and they also care about the brand, where the sheep were produced and whether it is Halal. By comparison 88.1% of rural residents are concerned about freshness, but they care less about branding, where the sheep were produced and whether the meat is Halal [3].

4.3.4. Eating Quality

Chinese consumers, especially the high income group pay more attention to meat eating quality [32]. Chinese consumers will increase their meat consumption if meat quality improves [1]. A survey indicated that only 76.4% and 67.5% of consumers were content with raw and cooked beef quality respectively, and 40% and 50% of consumers would increase their beef consumption if quality improved [19]. So by strengthening food security and improving meat quality this should increase meat consumption in China [1,13,18].

5. Beef Quality Requirements and Cooking Guidelines in China

Different people have different requirements for meat quality, and meat eating quality is influenced by many factors such as breeding, the processing of animals, the type of cut, cooking methods and so on. So, understanding consumer needs in terms of eating quality is important so these needs can be better satisfied. A lack of knowledge about how to cook beef and sheep meat is also a limitation for increasing meat consumption [19]. To provide beef meat with enhanced quality the palatability assurance critical control point (PACCP) technique developed in Australia has been introduced to Chinese meat research and industry. This system has encouraged the Chinese industry to focus on improving meat eating quality, by working across the whole meat supply chain, but this approach is in its infancy.

Tenderness, flavor and juiciness are the most important eating quality traits for Chinese beef consumers [33]. For beef cooked in a hot pot, the weightings for the importance of tenderness, flavour and juiciness were 0.38, 0.41, and 0.21 respectively [33]. For steak the weightings are 0.5, 0.38 and 0.12 respectively [33]. This indicates that tenderness is the most important eating quality trait for steak, and consumers pay more attention to flavor when eating beef cooked in a hot pot. Australian meat scientists have applied a four-trait approach for indicating beef eating quality which is called MQ4 = 0.4 x tenderness + 0.1 x juiciness + 0.2 x flavour + 0.3 x overall liking, and they also developed a 3-trait approach using a discriminant function to give MQ3 = 0.53 x tenderness + 0.17 x juiciness + 0.30 x flavour [34]. Comparing the weightings for tenderness, flavor and juiciness for Chinese steak eating quality to the weightings developed using the Australian 3-trait approach, it is seen that consumers have

a similar requirement for tenderness across countries, but Chinese consumers pay more attention to flavor and less to juiciness.

Chinese consumers like beef with shear force values below 43.0 N and consider it tough when shear force exceeds 51.3 N for beef cooked in a hot pot [33]. For steak the thresholds are 39.2N and 51.9 N, respectively. It is hypothesized that consumers will accept a higher shear force when beef is cooked in a hot pot as the beef is sliced very thinly, and is therefore easier to chew. Destefanis et al (2008) studied the relationship between beef consumer tenderness perception and Warner–Bratzler shear force and proposed that beef with shear force values less than 42.9 N be classified as tender and greater than 52.7N as tough [35]. USDA standards for beef tenderness certification classify meat with a shear force value of 43.25 N or lower to be "Certified Tender" and meat of 38.25 N and lower to be "Certified Very Tender" [36]. These results demonstrate that Chinese consumers have similar acceptance thresholds in terms of steak tenderness.

Tenderloin, eye of knuckle and striploin are suited for beef hot pot [33]. Wu (2016) proposed that knuckle undercut, eye of knuckle and tri-tip as well as tenderloin and the spencer roll were suited for beef hot pot [37]. Consumers of different genders and ages have different requirements for eating quality as it has been found female consumers put a higher emphasis on flavor [37].

Marbling affects beef eating quality [38,39,40], and contributes to flavor, juiciness and tenderness for Chinese consumers [33,40,41]. Chinese consumers like beef steak with a marbling grade of A3 (Japanese beef grading system, average intramuscular fat content IMF 11.3%) and can not differentiate between A4 (average IMF 17.6%) and A5 grades (average IMF 24.6%). Interestingly meat from A5 carcasses did not score higher in panel testing than meat from A4 carcasses [40]. As a result grade A4 was proposed as the top grade to aim for in beef fattening systems in China after considering consumer preference and fatting costs [40]. However, another study indicated that an IMF of 14% is sufficient to meet the eating quality expected by Chinese consumers [41]. Alternatively, if the IMF reaches 17% sensory acceptance will decrease [41]. The results from Zhu (2016) and Shi (2016) are slightly different in terms of what is the upper IMF threshold, which may be due to the consumers used for the studies as consumers were mainly from north China (Shandong province) in the study of Zhu (2016), whereas for the study of Shi (2016) the consumers were mainly from south China (Jiangsu province). An Australian study conducted by Thompson (2004) examined the relationship between consumer sensory scores and intramuscular fat percentage using data from 3613 striploin samples [38]. The results of this study showed curvilinear relationships between sensory scores for tenderness, juiciness, like flavor and overall liking and intramuscular fat percentage, and these relationships plateaued between 15 and 17% intramuscular fat, which is similar to the findings of Zhu (2016).

Sauced beef is the most popular traditional Chinese beef product. This beef is long cooked (about 3 to 4 hours) with soy sauce, spice mixture and salt. Sauced beef is produced from hot boned outside flat, topside, shank and knuckle. The effect of aging and cut type on the eating quality of sauced beef was investigated, and it was suggested that shank meat and knuckle (round) are the best for sauced beef, in terms of eating quality and the striploin and topside were not recommended for the production of sauced beef because they have low tenderness and light flavour [42]. For this product hot boned beef without aging can be utilized and this will meet consumer demands, and hot boned beef without aging also is beneficial and profitable for foodservice [42].

6. Sheep Meat Quality Requirements and Cooking Guidelines

There have been few studies of the Chinese consumer requirements in terms of sheep meat eating quality. The eating quality of stewed sheep meat was investigated and the results showed that sheep meat odor, tenderness and juiciness were the most important factors [43]. Ageing time and ageing temperature effects on the tenderness of stewed sheep meat were studied by Li (2016), and the results proposed that a shear force of 34±0.80 N or less is best for consumption, based on testing of the *m. gluteus medius* muscle (rump) aged for 9 days from Ujumqin fat-tail sheep [44]. Hopkins et al (2006) examined the relationships between sensory traits and shear force using m. *longissimus thoracis et lumborum* (LL), and proposed that a threshold shear force of about 27 N is a useful conservative target to meet consumer requirements for eating quality, with 40 N a less conservative target [45]. The level of 34 N proposed by Li (2016) suggests Chinese consumers should have similar tenderness requirements for sheep meat to Australian consumers [44].

The preparation of roast sheep meat was recorded in the early agricultural book <qi min yao shu> 1400 years ago and Kebab is a very popular cooking method all over China [46]. Research [47] studied roasted sheep meat eating quality using 8 trained panelists, and the results showed that tenderness, juiciness and flavor are the most important characteristics, and the following eating quality regression equation was developed: EQ score = 0.29 + 0.84 x flavor - 0.30 x tenderness + 0.47 x juiciness. Based on this model eating quality is first class (most suitable) when the score is over 6, and the least acceptable if the score is 4-5 (basic suitable). Also, breed, cut of meat and age of the sheep all have a significant effect on roast lamb eating quality [47]. For example, the Tan and Jinzhong breeds gave the highest scores after roasting followed by Xinjiang and Ujimqin breeds with Ujimqin sheep crossed with the small tailed Han breed giving the lowest scores [47].

Though Chinese meat scientists have done some work to establish consumer eating quality requirements, compared to large scale programs in other countries [38,48], the coverage and scale has been minimal considering the size of China with complicated economic and ethnic situations, and more work is needed to accurately know what consumers of beef and sheep meat really desire.

7. Conclusion

Consumption patterns amongst Chinese consumers have changed and more beef and sheep meat has been

consumed per capita. This has increased the levels of imported beef and sheep meat although the trade deficit is increasing, the prices of beef and sheep meat is rising and local production can not meet the huge market demand.

The quantity and quality requirements of Chinese consumers of beef and sheep meat are different between urban and rural residents, regions, and the influencing factors include price, income, religious beliefs, flavor, nutritional value, dietary habits, safety, eating quality, convenience of purchase, ease of cooking and time of year (eg weekend and holidays). The concern of consumers about food safety is rising, but as they do not have enough knowledge to identity meat safety concerns there is a need to help them make rational purchase decisions. There is a consumption trend for high quality meat in China, and low meat quality has become a factor limiting meat consumption. Though some quality control techniques such as PACCP have been introduced to China, this is at the infancy stage and has a long way to go to provide whole of industry coverage. It seems that Chinese consumers may have similar thresholds for tenderness acceptability as Western consumers, but according to region have different requirements for traits like flavor and marbling. However, the understanding of consumer requirements in China is limited and consumer segmentation is important, thus more work needs to be undertaken to understand the full spectrum of consumer requirements in terms of eating quality. The away from home consumption of beef and sheep meat has increased markedly and this has increased the demand for quality and quantity. However, consumers do need education on how to cook beef and sheep meat at home and how to identify quality and this requires urgent attention by the Chinese meat industry, with contributions from scientists.

For exporting countries, it is a basic requirement to understand the different quality requirements between urban and rural, regions and seasons, so as to establish clear market targets for different consumers and adjust supply according to seasons. Furthermore, Chinese consumers have their favorite cooking methods and these cooking methods need cuts with different meat quality. Considering Chinese beef and sheep meat quality is low now, but steak, roast and hot pot which need high quality beef and sheep meat is popular all over the China, the supply of high quality meat to the Chinese market should provide the ability to meet consumer demand and increases returns.

Acknowledgement

This work was supported by the project of National Natural Science Fund of China (31301514, 31271901), the Specialized Research Fund for the doctoral Program of Higher Education (20123702120002), the National Beef Cattle Industrial Technology System (CARS-038), an earmarked fund for Shandong province agricultural innovation team (SDAIT-12-011-09), Shandong province natural fund committee (ZR2015CQ013) and Jiangsu Collaborative Innovation Center of Meat Production and Processing, Quality and Safety Control. The senior author wishes to thank the NSW Department of Primary Industries, Cowra, Australia for hosting him for one year as a visiting scientist, during which time he prepared this review.

References

[1] Chen, Q. *Study on the meat consumption of urban and rural residents in China* (Master's thesis). 2010. [Online]. Available: http://www.cnki.net/KCMS/detail/detail.aspx?QueryID=2&CurRec=1&recid=&filename=2010171159.nh&dbname=CMFD2011&dbcodec. [Accessed Jan. 16, 2016].

[2] Li, F. *A study on behavior of consumer's purchase quality safety beef – based on the survey in Jilin province* (Master's thesis). 2012. [Online]. Available: http://www.cnki.net/KCMS/detail/detail.aspx?QueryID=4&CurRec=1&recid=&filename=1013126799.nh&dbname=CMFD201301&dbcode=CMFD&pr=&urlid=&yx=&v=MjQ0NjRSTCtmWWVkbUZ5emtWcjNNVkYyNkhiSzZHTmJGcHBFYlBJUjhlWDFMdXhZUzdEaDFUM3FUcldNMUZyQ1U=. [Accessed Jan. 16, 2016].

[3] Ding, L. *Research on the current situation and future trend of mutton supply and demand in China* (Doctoral dissertation). 2014. [Online]. Available: http://www.cnki.net/KCMS/detail/detail.aspx?QueryID=6&CurRec=1&recid=&filename=1014221386.nh&dbname=CDFD1214&dbcode=CDFD&pr=&urlid=&yx=&v=MjkxNjhIOUxFcVpFYlBJUjhlWDFMdXhZUzdEaDFUM3FUcldNMUZyQ1VSTCtmWWVkbUZ5M2hXcnpBVkYyNkdyRzY=. [Accessed Jan. 16, 2016].

[4] Lv, P. *China's beef supply and demand analysis* (Master's thesis). 2010. [Online]. Available: http://www.cnki.net/KCMS/detail/detail.aspx?QueryID=0&CurRec=2&recid=&filename=2010170942.nh&dbname=CMFD2011&dbcode=CMFD&pr=&urlid=&yx=&v=Mjg3MDNMdXhZUzdEaDFUM3FUcldNMUZyQ1VSTCtmWWVkbUZ5em1Wci9BVjEyNkhySy9IdGpJclpFYlBJUjhlWDE=. [Accessed Jan. 16, 2016].

[5] Zhang, H., Paijmans, J. L., Chang, F., Wu, X., Chen, G., Lei, C., Yang, X., Wei, Z., Bradley, D. G., Orlando, L. and Hofreiter, M. Morphological and genetic evidence for early Holocene cattle management in northeastern China. *Nature Communications*, 4, 657-678. Nov.2013.

[6] Xie, C. The origin and development of Chinese animal husbandry. *Agricultural Archaeology*, 1, 282-291. Jan.1985.

[7] An, L. A brief history of ancient Chinese animal husbandry development. *Agricultural Archaeology*, 1, 360-367,161. Jan.1988.

[8] Liu, l. *Research on relationship between the urban and rural residents' income and their consumption of livestock products of Hebei Province* (Master's thesis). 2012. [Online]. Available: http://d.wanfangdata.com.cn/Thesis_Y2143371.aspx. [Accessed Jan. 16, 2016].

[9] USDA. *Livestock and Poultry: World Markets and Trade*. 2015. [Online]. Available: http://apps.fas.usda.gov/psdonline/circulars/livestock_poultry.PDF. [Accessed Jan. 16, 2016].

[10] FAO. *Trade-Crops and livestock products.* 2015. [Online]. Available: http://faostat3.fao.org/browse/T/TP/E. [Accessed Jan.16, 2016].

[11] Liu, Y., Wang, M., Hu, X., Shi, Z. and Wang, H. Study on supply and demand of mutton market in China based on market model. *Animal Economy*, 50(14), 16-22.2014.

[12] Liang, D., Li, T. and Gai, L. Characteristics and influencing factors of rural residents' beef consumption. *Food and Nutrition in China*, 20(5), 50-52. May.2014.

[13] Shang, X. and Li, B. An analysis on consumption characteristic and question of animal products by urban and rural residents in China: based on the perspective of consumption structure and income disparities. *Ecological Economy*, 5, 45-52. Jun.2012.

[14] Zhang, H., Sun, S. and Feng, Y. Analysis of mutton consumption habit and buying behavior in urban and rural area. *Xinjiang State Farms Economy*, 1, 46-51. Jan.2014.

[15] Feng, J. *Study on the structure of livestock products consumption of urban and rural residents in northwestern China* (Master's thesis). 2013. [Online]. Available: http://www.cnki.net/KCMS/detail/detail.aspx?QueryID=0&CurRec=1&recid=&filename=1013345949.nh&dbname=CMFD201401&dbcode=CMFD&pr=&urlid=&yx=&v=MTY0MjNVUkwrZlllZG1GeXprVXI3QlZGMjZIYkM4RzlqSXBwRWJQSVI4ZVgxTHV4WVM3RGgxVDNxVHJXTTFGckM=. [Accessed Jan. 16, 2016].

[16] Wu, Q. and Xiao, H. Characteristics and influence factors of mutton consumption of China's urban and rural residents. *Agricultural Outlook*, 8, 71-75. Oct.2013.

[17] Lv, P. Characteristics and influence factors analysis of beef consumption for urban and rural residents in China. *Food and Nutrition in China*, 18, 45-49. Sep.2012.

[18] Wang, G. *China's Cattle-Beef Chain* (Doctoral dissertation). 2005. [Online]. Available: http://d.wanfangdata.com.cn/Thesis_Y773688.aspx. [Accessed Jan. 16, 2016].

[19] Li, J. *Study on the characteristic and influence factor of beef consumption in China* (Master's thesis). 2006. [Online]. Available: http://d.wanfangdata.com.cn/Thesis_Y1010215.aspx. [Accessed Jan. 20, 2016].

[20] Jiang, H., Xin, X. and Yin, J. Urban and rural animal product consumption in China and influencing factors analysis. *Chinese Rural Economy*, 12, 48-54. Dec.2002.

[21] Ding, L. and Xiao, H. Mutton consume in rural and urban China and prospect analysis. *Price: Theory & Practice*, 9, 90-91. Sep.2013.

[22] Shi, Y. Beef consume in China and influencing factors analysis. *Economic Management*, 4, 53-55.Apr. 2008.

[23] Li, J. *Production structure adjustment of animal husbandry based on animal product consumption* (Doctoral dissertation). 2008. [Online]. Available: http://d.wanfangdata.com.cn/Thesis_Y1422554.aspx. [Accessed Jan. 20, 2016].

[24] Si, Z. Study on the status and forecast of beef consumption in China. *Food and Nutrition in China*, 18, 54-57. Sep.2012.

[25] Xia, X. and Li, B. Study of Chinese urban resident outdoor food consumption. *Inner Mongolia social sciences*, 32, 110-115. Mar.2011.

[26] Li, J., liu, N., Amanguli and Zhang, Y. Analysis of mutton demand in Xinjiang. *Modern Animal Husbandry*, 11, 1-3. Nov.2013.

[27] Ding. L. and Xiao, H. Influencing factors of mutton demand and supply and future trend in China. *Journal of Agrotechnical*, *9*, 22-31. Sep.2014.

[28] Sans, P. and Combris, P. World meat consumption patterns: An overview of the last fifty years (1961–2011). *Meat Science*, 109, 106–111. Nov.2015.

[29] Wang, B. and Xiao, H. An analysis of reasons and countermeasures on rising mutton price in China. *Agricultural Economics and Management*, 5, 82-89.May.2013.

[30] Geng, Z. and Xiao, H. An empirical study of mutton price rising impact on residents' mutton consumption: based on provincial panel data from 2000-2011. *Agricultural Economics and Management*, 1, 92-98. Jan.2015.

[31] Wang, S., Li, B., and Geng, N. Why rapid lamb price increase did not cause significant supply surge: based on lamb prices rising in the last ten years. *Agricultural Modernization*, 35, 743-749. Jun.2014.

[32] Wang, W. *Quality, safety and demand for meat in urban China* (Doctoral dissertation). 2014. [Online]. Available: http://www.cnki.net/KCMS/detail/detail.aspx?QueryID=0&CurRec=1&recid=&filename=1014221379.nh&dbname=CDFD1214&dbcode=CDFD&pr=&urlid=&yx=&v=MDQ1NjVyRzZIOUxMcHBFYlBJUjhlWDFMdXhZUzdEaDFUM3FUcldNMUZyQ1VSTCtmWWVkbUZ5emdVNy9CVkYyNkc=. [Accessed Jan. 20, 2016].

[33] Mao, Y. *Study on palatability assurance critical control point of beef* (Master's thesis). 2008. [Online]. Available: http://d.wanfangdata.com.cn/Thesis_Y1374525.aspx. [Accessed Feb. 21, 2016].

[34] Watson, R., Gee, A., Polkinghorne, R. and Porter, M. Consumer assessment of eating quality–development of protocols for Meat Standards Australia (MSA) testing. *Animal Production Science*, 48, 1360-1367. Nov.2008.

[35] Destefanis, G., Brugiapaglia, A., Barge, M. T. and Dal Molin, E. Relationship between beef consumer tenderness perception and Warner–Bratzler shear force. *Meat Science*, 78, 153-156. Mar.2008.

[36] ASTM. ASTM F 2925-11 *Standard specification for tenderness marketing claims associated with meat cuts derived from beef*. Vol. 2014. 2011.

[37] Wu, B. *Research on evaluation of beef eating quality and method of improving beef values about Hindquarter* (Master's thesis). 2011. [Online]. Available: http://d.wanfangdata.com.cn/Thesis_Y1932480.aspx. [Accessed Feb. 21, 2016].

[38] Thompson, J. M. The effects of marbling on flavour and juiciness scores of cooked beef, after adjusting to a constant tenderness. *Animal Production Science*, 44, 645-652.Aug.2004.

[39] Corbin, C. H., O'Quinn, T. G., Garmyn, A. J., Legako, J. F., Hunt, M. R., Dinh, T. T. N., Rathmann, R. J., Brooks,J. C. and Miller, M. F. Sensory evaluation of tender beef strip loin steaks of varying marbling levels and quality treatments. *Meat Science*, 100, 24-31. Feb.2015.

[40] Zhu, H. *Quality traits and sensory evaluation of beef in China* (Master's thesis). 2012. [Online]. Available: http://d.wanfangdata.com.cn/Thesis_Y2116681.aspx. [Accessed Feb. 21, 2016].

[41] Shi, J. *The study on relationships between marbling and meat color and beef qualities* (Master's thesis). 2011. [Online]. Available: http://d.wanfangdata.com.cn/Thesis_Y2038803.aspx. [Accessed Feb. 21, 2016].

[42] Ren, L. *Effects of different parts and different postmortem states on the eating quality of Chinese traditional sauce beef* (Master's thesis). 2013. Shandong Agricultural University, Taian.

[43] Yang, Y. *Research on Evaluation technology of mutton eating quality* (Master's thesis). 2010. [Online]. Available: http://www.cnki.net/KCMS/detail/detail.aspx?QueryID=4&CurRec=1&recid=&filename=2010171024.nh&dbname=CMFD2011&dbcode=CMFD&pr=&urlid=&yx=&v=MTY2NDFYMUx1eFlTN0RoMVQzcVRyV00xRnJDVVJMK2ZZZWRtRnl6aFU3L09WMTI2SHJLL0g5SE9xNUViUElSOGU=. [Accessed Feb. 21, 2016].

[44] Li, L. *Effects of temperature on the post-mortem aging and sensory properties of mutton* (Master's thesis). 2003. [Online]. Available: http://d.wanfangdata.com.cn/Thesis_Y507422.aspx. [Accessed Feb. 21, 2016].

[45] Hopkins, D. L., Hegarty, R. S., Walker, P. J. and Pethick, D. W. Relationship between animal age, intramuscular fat, cooking loss, pH, shear force and eating quality of aged meat from sheep. *Animal Production Science*, 46, 879-884. Jul.2006.

[46] Jia, S. *Qi min yao shu*. 533-544. [Online]. Available: http://book.guqu.net/qiminyaoshu/. [Accessed Feb. 21, 2016].

[47] Xue, D. *Study on roast characteristics and suitability of different varieties lamb* (Master's thesis). 2012. [Online]. Available: http://www.cnki.net/KCMS/detail/detail.aspx?QueryID=0&CurRec=1&recid=&filename=1012414020.nh&dbname=CMFD2012&dbcode=CMFD&pr=&urlid=&yx=&v=MTc0MTBIT3I1RWJQSVI4ZVgxTHV4WVM3RGgxVDNxVHJXTTFGckNVUkwrZlllZG1GeXpnVkx2S1ZGMjZITGU1R3Q=. [Accessed Feb. 21, 2016].

[48] Polkinghorne, R. J. Implementing a palatability assured critical control point (PACCP) approach to satisfy consumer demands. *Meat Science*, 74, 180-187. Sep.2006.