Consumers' Preferences for Quality and Safety Attributes of Milk Products in Niger: A Best-Worst Scaling Approach

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Abstract: The overall objective of this research was to determine consumers' preferences for quality and safety attributes of milk products using advances in the best-worst scaling approach. A list of 16 quality and safety attributes of milk products based on previous studies was compiled and used in this study. The balanced incomplete block design technique was used to build the questionnaire administered to respondents in the data collection. The multinomial mixed logit was employed to analyze the data. Results suggest that nutritive value, shelf life, availability, purity and safety are the most important attributes of milk product; while origin, fat content, food miles, packaging and handling convenience are the least importance attributes of milk products to consumers. The study concludes that demand for dairy products can be significantly stimulated in the study area when these most important attributes have been considered by producers, processors and marketers.

Key words: Best-worst scaling, consumers' preferences, quality and safety attributes, milk products.

1. Introduction

Milk and dairy products contribute not only to household livelihoods, food security and nutrition, but also provide relatively quick returns, as well as an important source of cash income for several small-scale producers. In addition, milk is one of the most nutritionally complete foods available on food markets to date and it is the only food when used alone that is capable of sustaining human life.

Previous studies indicate that consumers are also becoming increasingly interested in how milk and milk products they consumed are produced, processed and transported [1]. A major challenge for producers, processors and marketers in the food industry is to predict consumer preferences for food products, because food consumers represent the essential demand for agricultural products and this demand is

always not stable. Moreover, several studies [2, 3] have been undertaken to determine consumer preferences for food product attributes and respective willingness to pay for various product characteristics, thereby providing products with desirable attributes to consumers and keeping the market fresh and alive. Furthermore, the lack of food safety, food security, nutrition and profitability is a problem not inherent to nature but with unjust societal systems and institutions. Lusk [4] also argued that understanding why consumers prefer a given attribute is important to determine the presence of market failure and therefore the need for public policy intervention.

Synthesis of recent literature review shows that annual average milk consumption in developed and developing countries has been estimated to be 311 L/person and 34 L/person, respectively [5]. Milk consumption also heavily varies within the same country due to difference in income, types of animal raised, food culture and nutritional and therapeutic

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values [6]. The best-worst scaling has been increasingly used in many fields to determine the general food values to consumers generally when applied to specific agricultural products [3], to determine the general food values determined [4, 7], to analyze choices related to healthcare [8], to determine food and nutrition strategies on public health [9] and to determine farmers' adaptation strategies to climate change [10].

Measuring the importance or desirability of list of items has also been a common task and a challenge for many researchers. Ranking, rating and ordering have been the common methods used. However, a new method called maximum difference scaling or best-worst scaling was developed by Louviere [11], while worked in Alberta University. This best-worst scaling is superior to other methods, such rating scales, because it forces respondents to discriminate between items, so results obtained from best-worst scaling are easy to interpret [11]. Unlike the rating scale, the best-worst scaling can also be used to compare both the intra and inter attributes.

Milk and milk products are widely consumed in Niger due to increase urbanization and change in food regime, but little is known about consumers' preferences and market share for quality and safety attributes of milk. Understanding these kinds of information is important, because milk products can be viewed as sources of food as well as income for many agro-pastoral based families. The overall objective of this research was to determine consumers' preferences for quality and safety attributes of milk products, with specific objectives to determine the relative importance and market share for quality and safety attributes of milk products.

2. Materials and Methods

In this research, it has been assumed that milk consumers' utility may increase, when consumers are making purchase decision if milk products having desirable attributes are provided to them. Therefore, producers, processors and milk marketers should

consider what is important to consumers to strategically increase the profitability of their dairy industries. In addition, understanding the value which consumers place on the quality and safety attributes of milk can help producers to offer reliable products and to timely meet consumers' needs.

The best-worst scaling method is increasingly becoming a popular data collection tool in studying consumers' preferences. The best-worst scaling forces respondents to discriminate (make trade-offs) between scaled items and uses an underlying scale ratio of measurement [12]. This best-worst scaling method is consistent with consumer utility maximization. Based on this method, respondents are presented a set of items and they are demanded to indicate which one is the best and which is the worst [12]. For instance, the best-worst scaling method was applied to investigate the relative importance consumers place on food values and to study preferences for sustainable farming practices [13]. Furthermore, efficient estimates can be obtained when repeated choices are made by the same respondent, which is the case in this present study [14]. Finally, the best worst approach is gaining more popularity as a better alternative to the rating system and measuring value [15]. Therefore, the best worst approach reported above fit well in this present study related to consumers' preferences for quality and safety attributes of milk products. This is captured by the difference between the most preferred and least preferred items chosen from the set, when he or she is making a purchase decision. This can be mathematically represented as Eq. (1):

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad (1)$$

where, U_{ij} is the utility for consumer i choosing milk having attribute, V_{ij} and ε_{ij} are the deterministic component and the error term of utility, respectively.

Best-worst scaling was used to determine values which consumers placed on quality and safety attributes of milk products. Thus, the balanced incomplete block design (BIBD) approach was used to

design the questionnaire administered to respondents. The design used was balanced with respect to rows and each row represents a question format. And each attribute is replicated equal number of time in this questionnaire. In total, 16 quality and safety attributes of milk have been considered in this study as shown in Table 1. Sixteen blocks or questions and six elements or attributes were randomly assigned to each. This questionnaire was used to collect data at various places, such local market, shops, open vendor and hospitals, where milk products are sold to consumers.

Participants were recruited both in rural and urban locations so to diversify as much as possible the

characteristics of the respondents. In total, 80 rural consumers and 100 urban consumers were randomly selected and interviewed using in person interviews. This interview method is more preferred to email, phone and internet interview, because most Nigerien people can not be reached by phone and internet. Only one person of specific gender in a household was interviewed so as to increase the randomness of the sample. For each question, respondents are asked to choose which option of milk attributes they most preferred and which one they least preferred. A sample question for this study, based on the best-worst scaling method is presented in Table 2.

Table 1 List of most important attributes of milk products compiled using previous research findings.

Attributes	Characteristics/descriptions
Fat content	The amount of fat content in the milk
Color	The nature color of milk ranges from white to yellowish
Taste	The extent to which the consumption of milk is appealing to senses
Packaging	How the milk is wrapped or presented to the consumers
Labeling	The extent to which the milk can be easily identified and traced back
Nutritive value	Amount and type of fat, proteins, vitamins, etc.
Purity	The extent to which the milk is produced without additives
Safety/health risks	The extent to which consumption of milk will not cause illness
Hygiene/cleanliness	The extent to which the milk meets some basic sanitary standard
Shelf life	How long the milk can be kept before undergoing spoilage
Availability	The extent to which the milk is easy to find
Handling convenience	The means by which milk is transported to the consumers
Breed of animals	The type of animal used in the production of milk
Origin/traceability	The extent to which the identities and locations of producers and processors are known
Food miles	How long the milk is transported to the final consumers
Therapeutic value	The extent to which milk can treat certain ailments

Table 2 A sample of best-worst question.

Most preferred	Attributes	Least preferred
☐	Taste (The extent to which the consumption of milk is appealing to senses)	☐
☐	Label (The name given to the milk to know its traceability)	☐
☐	Nutritive value (The extent to which milk meets your food requirement)	☐
☐	Shelf life (How long the milk withstands before undergoing spoilage)	☐
☐	Food miles (How long the food travels before reaching the consumers)	☐
☐	Therapeutic value (The extent to which milk can treat certain diseases)	☐

Which of the following options of milk attributes would you most and least prefer? (Check only one option as the most important and one as the least important.)

The best worst scaling and count based methods are the most widely used techniques to analyze choice experiment data. Thus, Lusk and Briggeman [4] stated that in k items on a set of choices, there are $k \times (k - 1)$ possible best-worst combinations. Choosing one pair out of $k \times (k - 1)$ possible pairs, respondents are assumed to allocate the maximum difference to this choice.

Following the method in Ref. [4], let a_k represents the location of value k on the specific scale of importance. Thus, an unobserved level of importance for individual i could be expressed as Eq. (2):

$$P_{ik} = a_k + \varepsilon_{ik} \quad (2)$$

where, P_{ik} is the true level of importance for individual i and ε_{ik} is an error term introduced to take into account for unobserved factors.

The probability that items k and j are selected out of the set as the best and the worst is equal to the probability that the difference between P_{ik} and P_{ij} is greater than all other $[k \times (k - 1)] - 1$ options in the choice set. Assuming the error term has an independently and identically distributed (iid), a multinomial mixed logit model can be used to determine the probability expressed as Eq. (3):

$$\text{Probability } (k \text{ chosen best and } j \text{ worst}) = \frac{\text{Exp}(\beta_k - \beta_j)}{\sum_{i=1}^K \sum_{m=1}^K \text{Exp}[(\beta_i - \beta_m) - K]} \quad (3)$$

This regression analysis was used to determine the relationship among several pair variables and then identify how a change from one affects the other. The estimation of the model helps to determine which attribute is the most preferred and which is one the least preferred.

Results from the estimated mixed multinomial logit model were also used to rank preference. Then, preference share was calculated based on the following Eq. (4):

$$\text{Percentage (option } j \text{ chosen)} = \frac{e^{X\beta_j}}{\sum_{k=1}^J e^{X\beta_k}} \quad (4)$$

where, $V_j = X\beta_j$ is utility for option j and $V_k = X\beta_k$ is utility for option k .

The mean and standard deviation for each attribute were used to compute the market share above and below zero. First, the ratio of the mean by the standard deviation for each attribute was computed by assuming that this follows the normal standard distribution. Second, the function normdist in excel was used to determine the probability either above or below zero and this probability corresponds to the market share. And thirdly, one minus the probability was found in step two to get the market shares either above or below zero, respectively. Thus, the equation used to calculate market share either above or below zero for a given attribute can be expressed as Eq. (5):

$$\text{Market share}_i = \text{normdist}\left(\frac{\text{mean}_i}{\text{standard deviation}_i} \sim Z \text{ distribution}\right) \quad (5)$$

And $1 - (\text{market share}_i)$ was used to compute the market share either above or below zero depending on the value got in Eq. (5). Finally, the likelihood ratio test was used to test whether a significant difference exists in urban vs. rural consumers, male vs. female consumers, young vs. old consumers, married vs. bachelor consumers, large family vs. small family consumers, educated vs. uneducated consumers and high income vs. low income consumers. Thus, the log-likelihood ratio test can be mathematically expressed as Eq. (6):

$$\text{LLF} = 2 (\log\text{LLFM} - \log\text{LLRM}) \sim \chi_{\text{df}}^2 \quad (6)$$

where, LLF is the likelihood function, logLLFM is log-likelihood value for the full model, logLLRM is the log-likelihood value for the restricted model. The difference between these two functions is assumed to follow the chi-square distribution with degree of freedom, as Eq. (7):

df = numbers of parameters in the full model – numbers of parameters in the restricted model (7)

If the chi-square calculated (χ^2_{17}) is greater than the chi-square tabulated ($\chi^2_{cal} = 27.58$), then it is assumed that significant difference exists between socioeconomic categories.

3. Results and Discussion

First, summary statistics of socioeconomic variables were presented in Table 3. Table 3 provides summary statistics for respondents included in this study analysis. Most of the respondents were male (75%), married (80%) and uneducated (82%). They have an average age of about 41 years, and monthly average household income was about 55,000 FCFA which is equivalent to \$100. Average household size was about seven persons, and average herd size was about two animals.

In addition, the likelihood ratio test was employed to test whether significant difference exists for urban vs. rural consumers ($\chi^2_{17} = 47$, $\chi^2_{cal} = 27.58$), male vs. female consumers ($\chi^2_{17} = 55$, $\chi^2_{cal} = 27.58$), young vs. old consumers ($\chi^2_{17} = 37$, $\chi^2_{cal} = 27.58$), married vs. bachelor consumers ($\chi^2_{17} = 41$, $\chi^2_{cal} = 27.58$), large family vs. small family consumers ($\chi^2_{17} = 24$, $\chi^2_{cal} = 27.58$), educated vs. uneducated consumers ($\chi^2_{17} = 41$, $\chi^2_{cal} = 27.58$), and high income vs. low income consumers ($\chi^2_{17} = 30$, $\chi^2_{cal} = 24.99$), and results show that consumers' socioeconomic characteristics (except family size) significantly influence the preference of milk attributes. This implies that consumers in rural area vs. urban one, female vs. male consumers, young vs. old consumers, educated vs. uneducated consumers and high income vs. low income consumers differently valued milk attributes, while

there is no preference difference between large families vs. small family consumers for milk attributes.

Table 4 shows parameter estimates from the mixed multinomial logit model. Coefficients with positive sign indicate that attributes are preferred, while coefficients with negative signs indicate that attributes are not preferred by consumers. Results reveal that nutritive value, shelf life, availability, purity and safety are positive and statistically significant, implying that consumers preferred to have milk products with these attributes. It also shows that origin, fat content, food miles, packaging and handling convenience were negative and statistically significant, indicating consumers significantly discounted milk products having these attributes. And standard deviation regardless of location (rural or urban) for fat content, color, shelf life, purity, safety, hygiene, availability, handling convenience, type of animals, origin, food miles and therapeutic value were statistically significant, implying that these parameters indeed randomly vary over the population.

Secondly, results from Table 4 were used to compute shares of preference as shown in Table 5. Table 5 shows the relative importance for the 16 attributes of milk attributes as estimated by the mixed multinomial model. The importance of each milk attribute was estimated relative to hygiene for the pooled and rural and packaging for urban consumers, respectively. Results reveal that nutritive value, on average, is the most important milk attributes and significantly more important than hygiene. Shelf life, availability, purity and safety are the next most important

Table 3 Characteristics of surveyed respondents.

Variables	Definition	Mean	Standard deviation
Age	Age in years	40.913	12.671
Gender	1 for female, 0 for male	0.258	0.439
Marital status	1 for married, 0 for unmarried	0.795	0.405
Family size	Numbers of persons in the household	6.440	4.547
Herd size	Numbers of animals owned by the family	1.408	2.848
Education	1 if educated, 0 if uneducated	0.827	0.379
Income	Monthly household income in 1,000 FCFA	55.086	14.344

Table 4 Multinomial mixed logit estimates of milk attribute based utility for combined, urban and rural consumers.

Characteristics	Parameters	Combined		Urban		Rural	
		Value	SE	Value	SE	Value	SE
Fat content	Mean	-0.565**	0.0955	-0.609**	0.1415	-0.602**	0.1449
	SD	1.367**	0.1210	1.620**	0.1976	1.426**	0.1783
Color	Mean	0.063	0.0861	0.087	0.1336	0.052	0.1301
	SD	1.016**	0.1254	1.252**	0.1894	1.105**	0.1861
Taste	Mean	-0.062	0.0878	-0.133	0.1358	-0.003	0.1332
	SD	0.730**	0.1460	1.043**	0.1974	0.736**	0.2180
Packaging	Mean	-0.316**	0.0877	-0.479	0.000	-0.221	0.1280
	SD	0.025	0.8439	0.055	0.9532	0.050	0.326
Labeling	Mean	0.022	0.0923	0.155	0.1369	-0.111	0.1402
	SD	0.036	10.339	0.407	0.3896	0.061	1.3185
Nutritive value	Mean	0.951**	0.0844	1.113**	0.1570	0.935**	0.1286
	SD	0.067	0.7607	0.238	0.5743	0.020	1.0819
Purity	Mean	0.315**	0.0816	0.517**	0.1428	0.315**	0.1248
	SD	0.522*	0.1728	0.667**	0.2358	0.654**	0.2290
Safety	Mean	0.205*	0.0858	0.323*	0.1454	0.109	0.1287
	SD	0.563**	0.1696	1.107**	0.1953	0.312	0.3839
Hygiene	Mean	0.787	0.000	0.985**	0.1438	0.691	0.000
	SD	0.445*	0.2070	0.976**	0.2129	0.488	0.2668
Shelf life	Mean	0.525**	0.0974	0.509**	0.1676	0.602**	0.1474
	SD	1.014**	0.1532	1.278**	0.2285	1.090**	0.2195
Availability	Mean	0.357**	0.0837	0.359**	0.1390	0.400**	0.1335
	SD	0.824**	0.1358	0.900**	0.2055	1.227**	0.1851
Handling convenience	Mean	-0.282*	0.0923	-0.333*	0.1466	-0.263	0.1427
	SD	0.671**	0.1566	1.063**	0.2047	0.872**	0.2063
Types of animals	Mean	-0.126	0.0889	-0.211	0.1363	-0.075	0.1331
	SD	1.125**	0.1248	1.425**	0.1844	1.160**	0.1769
Origin	Mean	-1.420**	0.1162	1.440**	0.1634	-1.623**	0.1791
	SD	1.110**	0.1669	1.179**	0.2536	1.159**	0.2367
Food miles	Mean	-0.328**	0.0985	0.514**	0.1508	-0.104	0.1539
	SD	1.678**	0.1293	1.769**	0.2083	1.972**	0.1981
Therapeutic value	Mean	-0.118	0.0925	-0.327*	0.1400	0.064	0.1383
	SD	1.611**	0.1159	1.913**	0.1944	1.679**	0.1765
Loglikelihood at convergence		-9,473		-4,934		-4,492	
Loglikelihood at zero		-1,0067.5		-5,278.5		-4,788.5	
Pseudo- R^2		0.06		0.06		0.06	
N individuals		185		100		85	

SD: standard deviation; SE: standard errors. ** and * are statistical significant levels at 1% and 5%, respectively. Zero values reported by Statistical Application Software (SAS) were used as basis for comparison.

milk attributes, while origin, fat content, food miles, handling convenience and packaging are the least important milk attributes. Table 5 shows that nutritive value has the highest preference share (14.14%), followed by hygiene (12%), shelf life (9.24%), availability (7.81%), purity (7.48%) and safety (6.7%);

while origin has the lowest preference shares (1.31%), followed by fat content (3.10%), food miles (3.93%), type of animal (4.81%) and therapeutic value (4.85%). As shown in Table 5, this general preference shares found for pooled data also specifically held for consumers' preference shares across location.

Table 5 Preference share for quality and safety attributes of milk products.

Variable	Preference share		
	Pooled	Urban	Rural
Fat content	3.10%	2.67%	2.99%
Color	5.82%	5.37%	5.76%
Taste	5.13%	4.31%	5.45%
Packaging	3.98%	3.04%	4.38%
Labeling	5.58%	5.75%	4.89%
Nutritive value	14.14%	14.97%	13.93%
Purity	7.48%	8.25%	6.35%
Safety	6.70%	6.79%	6.10%
Hygiene	12.00%	13.18%	10.92%
Shelf life	9.24%	8.18%	9.99%
Availability	7.81%	7.05%	8.15%
Handling convenience	4.12%	3.52%	4.20%
Type of animals	4.81%	3.98%	5.07%
Origin	1.31%	1.17%	1.08%
Food miles	3.93%	3.10%	4.92%
Therapeutic value	4.85%	3.54%	5.83%

Table 6 Market share for quality and safety attributes of milk products across location.

Characteristics	Combined		Urban		Rural	
	% above zero	% below zero	% above zero	% below zero	% above zero	% below zero
Fat content	0.34	0.66	0.35	0.65	0.34	0.66
Color	0.52	0.48	0.53	0.47	0.52	0.48
Taste	0.47	0.53	0.45	0.55	0.50	0.50
Packaging	0.00	1.00	0.00	1.00	0.00	1.00
Labeling	0.73	0.27	0.65	0.35	0.03	0.97
Nutritive value	1.00	0.00	1.00	0.00	1.00	0.00
Purity	0.73	0.27	0.78	0.22	0.59	0.41
Safety	0.64	0.36	0.61	0.39	0.64	0.36
Hygiene	0.96	0.04	0.84	0.16	0.92	0.08
Shelflife	0.70	0.30	0.65	0.35	0.71	0.29
Availability	0.67	0.33	0.66	0.34	0.63	0.37
Handling convenience	0.34	0.66	0.38	0.62	0.38	0.62
Type of animals	0.46	0.54	0.44	0.56	0.47	0.53
Origin	0.10	0.90	0.89	0.11	0.08	0.92
Food miles	0.42	0.58	0.61	0.39	0.48	0.52
Therapeutic value	0.47	0.53	0.43	0.57	0.52	0.48

Finally, Table 6 reports the percentage above and below the mean. The mean and standard deviation of each individual coefficient as presented in Table 4 were used to determine the market share above and below zero. Results show that nutritive value is preferred by all consumers (100%), against 96% for hygiene, against 73% for purity, against 70% for shelf life, against 67% for availability and against 52% for

color. Results also reveal that packaging is avoided by majority (100%) of consumers, against 90% for origin, against 66% for fat content and handling convenience, against 58% for food miles, against 54% for animal types and 53% for taste and therapeutic value. Results also revealed that this general market share found for pooled data equally holds across location (rural and urban).

4. Conclusions and Suggestion

Results reveal nutritive value, shelf life, availability; safety and purity are the most important attributes; whereas origin, fat content, handling convenience, packaging and food miles are the least important attributes. This indicates that consumers place a high preference for nutritive value, shelf life, availability, safety and purity attributes of milk products. Results also reveal that nutritive value has the highest preference share, followed by hygiene, shelf life, availability, purity and safety. This implies that consumers are more concerned about milk products with these attributes and this can significantly stimulate demand.

This study provides first-hand information for producers, processors and marketers to make better informed decision on how to increase the sale of milk products. This research output also helps people along the value chain of milk to provide consumers with desirable attributes of milk products, thereby enhance not only the profitability of their business, but also improve the overall welfare of consumers. Finally, future direction for research is to determine the influence of respondent characteristics on the relative importance for quality and safety attributes of milk products, the willingness-to-pay of the most important attributes and the welfare gain when marginally consumed milk is introduced in the market place.

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