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Consumers fear for novel food processing technologies: An application of food technology neophobia scale in the consumption of processed milk products in Northern Uganda

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ABSTRACT

New food processing technologies are continuously being introduced in the food industry due to the potential benefits such as longer product shelf life, convenience, sensory appeal, and nutritional superiority. Despite their potential benefits, consumers' perceptions and attitudes towards food processing technologies remain a complex phenomenon as consumers tend to take a more conservative stance concerning novel food processing technologies. This paper applied the Food Technology Neophobia Scale(FTNS) to assess the influence of food technology neophobia, and socio-economic factors on the consumption of processed milk products. Data was collected from 400 milk consumers in northern Uganda using structured questionnaires. Analysis was done in SPSS version 21, and binary logistic regression. Results show that milk consumers in northern Uganda are characterized by a high degree of food technology neophobia towards processed milk products (FTNS score of 62). Education($p=0.04$), income($p=0.08$), risk perception($p=0.00$), healthy choice($p=0.06$) and media role ($p=0.00$) were the major factors that influenced the consumption of processed milk products. The paper concludes that Food technology neophobia, food culture and tradition are the most important factors in the success of foods produced by novel technologies.

1. Introduction

New food processing technologies are continuously being introduced in the food industry due to their potential benefits such as longer product shelf life, convenience, sensory appeal, and nutritional superiority (Frewer et al. 2011). Despite the benefits of such technologies, consumers' perceptions and attitudes towards food processing technologies remain a complex phenomenon as consumers tend to take a more conservative stance concerning novel food processing technologies (Siegrist 2008; McKenzie, Metcalf, and Saliba 2021). Whereas it is generally believed that food processing technologies provide an opportunity for innovations in the agri-food sector, not all technologies are readily accepted by consumers. This is particularly so in situations where consumers are unsure of the risks associated with applications of such technologies in food production and processing (Rollin et al., 2011); (Chen 2008; Siegrist 2008); and (Frewer et al. 2011). Consequently, the success of any new product will largely depend on consumers' behavioral responses to its processing technology (Chen, Anders, & An, 2013).

To measure consumers' behavioral response to novel food processing technologies, a psychometric tool, the Food Technology Neophobia Scale (FTNS) was developed (Cox and Evans 2008). The FTNS has been proven to be a good measure of the level of consumers' neophobia towards foods processed using novel technologies. For instance, (Martins et al. 2019) found that food technology neophobia moderated consumers' perceptions of processed juice amongst Brazilian consumers; (De Steur, Odongo, and Gellynck 2016) found that Ugandan consumers had a high degree of food technology neophobia towards processed Matooke flour; and (Martins and Pliner 2012) found that food technology neophobia was a significant factor in determining consumers' perception towards foods produced by nanotechnology in Canada.

Although the FTNS is a valid and reliable measure of food technology neophobia (Cox and Evans 2008; Evans et al. 2010; Martins and Pliner 2012; Verneau et al. 2014b; Verneau et al. 2014a), it is important to appreciate that variations in consumers' location, technology, culture and the food in question may affect their acceptance and/or rejection of particular food products (Frewer et al. 2014); (Ronteltap et al. 2007). These contextual variations do not allow for a blanket application of the FTNS results from previous studies and contexts, hence a need for validation of the FTNS in different contexts. Further, existing literature on the application of FTNS is largely based on studies conducted in developed

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countries, such as Brazil (Martins et al. 2019), Australia (Chen, Anders, & An, 2013; Martins and Pliner 2012), Canada (Coppola et al. 2014; Verneau et al. 2014b) and Italy (Coppola et al. 2014). Only a few studies such as (De Steur et al. 2016) have focused applying the FTNS in developing country contexts. Additionally, most of the previous FTNS studies have dealt with food packaging related technologies such as nanotechnology, rather than the products produced by such technologies. Therefore, there is a need to conduct more studies on the applicability of the FTNS on food products produced by novel technologies.

Milk is a highly perishable product and its shelf-life largely depends on immediate processing and preservation (Sahu and Bala 2017). Much as milk processing and preservation technologies such as hydrostatic pressure technology, pulsed electric field technology, ultra-high temperature and cold pasteurization(Sonne et al. 2012) is old and known to most the world, milk consumers in northern Uganda still exhibit a high preference for unprocessed and/or locally processed milk products. It has been suggested that the observed preference for unprocessed and/or locally processed milk products is a result of consumers' fear for processed milk products. However, there is limited scientific evidence to back up these claims. It is therefore important to investigate and understand the neophobia/neophilia factors that underlines the observed milk consumption behavior of consumers in Northern Uganda. Using, Ultra-high temperature(UHT) milk, and pasteurized milk processing technologies, this paper applied the FTNS to assess the influence of food technology neophobia, and socio-economic factors on the consumption of processed milk products. The main hypothesis underlying this study is to establish whether the observed preference for unprocessed and/or locally processed milk products is a consequence of consumers' fear for processed milk products.

2. Materials and methods

2.1. Study area

The study was conducted amongst milk consumers in two Northern Ugandan districts of Gulu and Lira. Northern Uganda was purposively chosen because it has one of the lowest per capita milk consumption in Uganda. At 62 liters per capita (Balikowa 2011), milk conception in northern Uganda is below the World Health Organization (WHO) recommended minimum per capita consumption of 200 liters (Walther, Wechsler, Schlegel, & Haldimann, 2018). The low demand for processed milk products has translated into only 33% of milk produced in the region being processed, while up to 60% is sold and consumed as raw milk (Achan, 2018). While consumption of raw unprocessed milk might present a ready market for locally produced milk, unprocessed milk possess several risks to consumers. These risk could arise from milk contamination during milking and transportation, presence of zoonotic diseases such as brucellosis. To the producers, selling of raw milk implies a shorter shelf life and low market value. Specifically, the study targeted milk consumers within urban and peri-urban areas of Gulu and Lira cities. Urban and peri-urban milk consumers were purposively targeted because they have access and can afford processed milk products. They therefore present the best potential markets for processed milk products.

2.2. Sampling and data collection methods

Primary data was collected through face-to-face interviews using pre-tested, structured questionnaires between September and October 2018. The research instrument was pre-tested in the Gulu City with a community surrounding Gulu University to ensure its validity and reliability. Fully trained research assistants were deployed to administer the questionnaires. Before administering the questionnaire, respondents were briefed on the nature and context of the study. Even though all respondents knew what processed milk products are, each enumerator carried a picture of UHT and pasteurized milk products to show to the respondents. A multi-stage sampling technique was employed to select study respondents. The two cities of Lira and Gulu were purposively selected because they possess the highest potential for packed milk consumption. From each city, 50 households were randomly selected from each of the four divisions in Lira and Gulu respectively, giving a total sample size of 400 respondents.

The sample size was determined using a simple random sample equation for infinite populations (N >10,000) according to (Naing, Winn, and Rusli 2006). This sample size determination approach was adopted because the population in the study area was above the threshold value of 10,000 (Lira district: 410,516; Gulu: 443,273) (Bureau.Statistics 2017). The simple random sample equation is presented in equation 1.

$$n = \frac{Z^2 P(1-P)}{b^2} \quad (1)$$

Where n= sample size

Z = z statistics for level of confidence @ 95% = 1.96

P = expected prevalence or proportion of milk consumers = 40%

b = precision @ 5% = 0.05

$$\text{Sample size calculation n} = \frac{(1.96)^2\ 0.5(1-0.5)}{(0.05)^2} = 400$$

Accordingly, the study obtained the largest possible sample size with a fixed sampling error and reliability.

Primary data was collected on consumer socio-economic characteristics such as age, marital status, income levels, education levels, consumption frequency, distance to the market, gender, occupation, and household size. Food technology neophobia was measured using the 13-items FTNS (Cox and Evans 2008). The FTNS statements were measured on a 5- point Likert scale (i.e., 1=strongly degree; 5=strongly agree).

2.4. Data analysis

Data was evaluated and checked for response errors and completeness. Complete data sets were coded and entered in the Statistical Package for Social Scientists (SPSS) version 21. Socio-economic characteristics were analyzed using frequencies and percentages. Multicollinearity was assessed using the Variance Inflation Factor (VIF); with the VIF for each factor was less than 10, indicating good variance of coefficient in the data set.

2.4.1. Exploratory Factor Analysis (EFA)

Exploratory Factor Analysis (EFA) was used to assess the consumers level of food technology neophobia basing on the 13-item FTNS statements (De Steur et al. 2016). The EFA was deemed appropriate because there were at least ten times as many respondents for every variable and the absolute sample size was greater than 100 (De Steur et al. 2016). Exploratory Factor analysis (EFA) was conducted using Principal Component Analysis (PCA) with varimax rotation to determine the most appropriate factor solutions. This was followed by a confirmatory factor analysis (CFA) to establish the most appropriate factor solutions. To justify the development of a composite variable for each of the factors, Cronbach's alpha internal consistency test was performed on the derived EFA factors.

2.4.2. Binary logistic regression

To assess the influence of socio-economic and food technology neophobia factors on the consumption of processed milk products, a binary logistic regression was estimated. A binary logistic model is considered appropriate where the dependent variable is categorical with two categories. In this case, packed milk consumption was measured in two categories i.e. 1= consumed, 0=otherwise.

The binary logistic regression model is presented as:

$$MC = \beta 0 - n + \beta 1 X1 - Xn + \delta 0 - n + \delta X1 - Xn + \mu \quad (2)$$

Where: MC is processed milk consumption; Xn is a vector of independent variables including socio-economic factors and FTNS factors (Table 1).

Table 1
Determinants of packed milk consumption.

Variables	Description	Expected sign	Source
Socio-demographic			
X_1 = Age	Age in complete years	+/-	Ayyaz *et al.* (2011); Verbeke (2005)
X_2 = Sex	Sex of respondents	+/-	Boer, (2016)
X_3 = Income	Average monthly income	+/-	(De Steur, Odongo, & Gellynck, 2016; Rollin et al, 2011)
X_4 = Marital status	Marital status	+/-	Barrena & Sánchez, 2013)
X_5 = Education level	Years spent in school	+/-	Kaya, (2016); Kikulwe, (2011)
X_6 = Household size	Number of people in a household	+/-	De Steur *et al.* (2016); Binninger, (2015)
X_7 = Distance	Distance to nearest market	+/-	De Steur *et al.* (2016)
Food technology neophobia factors			
X_1 = Risk perception	Risks associated with packed milk technology	+/-	De Steur, et al.(2016); Verneau, (2014)
X_2= Media role	Role of media in packed milk consumption	+/-	Coppola, et al., (2014); De Steur *et al.* (2016)
X_3 = Necessity	Usefulness of technologies	+/-	Vidigal *et al.,* (2015); (Sodano *et al* (2015)
X_4= Healthiness	Health consciousness of consumers	-	Siegrist, 2008); Vukasovič, (2016)

Table 2
Socio-demographic characteristics (n=400).

Characteristics	Categories	% Percentage
Sex	Male	39.0
	Female	61.0
Marital status	Married	60.7
	Unmarried	39.2
Age[a]	<20 years	12.7
	21-25 years	27.1
	26-30 years	22.9
	>30 years	37.3
Occupation	Self-business	52.4
	Private employees	41.7
	Gov't employees	5.8
Education level	None	3.7
	Primary	33.9
	Secondary	41.5
	Tertiary	21.0
Income level Per-Month	<100,000	42.2
	100,001-200,000	23.9
	200,001-500,000	24.6
	500,001-1000,000	6.6
	>1000,000	2.7
Household size	The average number of people living in the household	5.2
Market Distance	Average distance to the market	1
Packed milk consumption	Never	33.2
	Consumed	66.8
Packed milk Consumption Frequency	Never	33.2
	Once	15.1
	Twice	14.1
	2-3times	14.4
	>3times	23.2

3. Results

3.1. Socio-demographic characteristics

Majority (61%) of milk consumers were female, married, and within the age bracket of 30 years. Most (51%) of them were mainly engaged in self-businesses and earned UgShs 100,000 (about US$ 28) per month. The average household size was 5 persons and the average market distance traveled was 1 kilometer. About 33% of participants had never consumed processed milk products, while 23% consumed processed milk more than three times a week. In terms of education, close to 89% of the participants had some formal level of education (Table 2).

3.2. Food technology neophobia

3.2.1. Exploratory Factor Analysis (EFA)

An Exploratory Factor Analysis (EFA) with principal component analysis (PCA) and varimax rotation was conducted on the 13-item FTNS statements to obtain appropriate factor solutions. Prior to conducting the EFA, four food technology neophobia scale questions (Q3, Q5, Q7, and Q12) were reversed scored. Results of the Kaiser-Meyer-Olkin test (KMO=0.755) and Bartlett's Sphericity test (χ^2 =464.264, p<0.001) showed the adequacy of the sample for factor analysis. Cronbach's alpha test of internal consistency was 0.64, indicating good internal reliability (Gliem and Gliem 2003). The PCA with varimax rotation explained 50% of the total variation in the data (Table 3).

Based on the EFA, the FTNS factors was categorized into four components. The first component explained 22% of the total variance, is related to consumers' 'perceived risks' of foods produced by new food technologies. It is comprised of four statements (items 1, 3, 5, 7) such as *'There are plenty of foods around so we don't need to use new food technologies to produce more processed milk products.* The second component, explained 10% variation and relates to confidence in the role of media (items 2, 13). It contained statements such as *'the benefits of new food technologies are often grossly overstated'.* The third component, which explained 10% of the total variance, relates to perception that 'new food

Table 3
Factor loadings for the FTNS.

FTNS items	Mean	SD	F1	F2	F3	F4
1.There are plenty of tasty foods around so we don't need to use new food technologies to produce more	3	2	0.589			
2. New food technologies increases the natural quality of food®	3	2	0.702			
3. New food are healthier than traditional foods®	3	2	0.761			
4. Society should depend heavily on technologies to solve its food problems [R]	3	2	0.535			
5. The benefits of new food technologies are often grossly overstated	4	1		0.750		
6. The media usually provides a balanced and unbiased view of new food technologies®	3	2		0.747		
7. There is no sense trying out high-tech products because the ones I eat are already good enough	3	1			0.715	
8. It can be risky to switch to new food technologies too quickly	3	1			0.639	
9. New food technologies is something I am uncertain about	3	1				0.408
10. New food technologies may have long term negative environmental effects	4	1				0.717
11. New food technologies are unlikely to have long term negative health effects®	3	2				0.658
Percentage variance explained (50%)	22					
Cronbach's Alpha internal consistency	0.64					
Measure of Sampling Adequacy (KMO)	0.76					
Bartlett's test of Sphericity	464.26					
FTNS Overall Score on the Food Technology Neophobia Scale	3(62)					

Note: F1= Perception of risk; F2= Media role/information; F3= New food technologies are unnecessary; F4= Healthy choice.
[R] Means the items were reversed scored.

Table 4
Effect of socio-economic and FTNS factors on consumption of processed milk (n=400).

Variable	B	SE	Wald	Sig	Exp(B)	Marginal effects dy/dx (Standard Errors)
Socio-demographic factors						
Sex (1= male)	-0.231	0.253	0.962	0.327	0.780	-0.079 (0.053)
Age	-5.240	3.809	1.893	0.169	0.005	-0.164 (0.176)
Marital status (1 =married)	-0.203	0.441	0.211	0.646	0.817	-0.017 (0.089)
Household size	0.666	0.428	2.421	0.120	1.946	0.151 (0.097)
Education level	-0.891	0.441	4.081	0.043*	0.410	-0.012* (0.034)
Employment (1= employed)	-0.280	0.478	0.343	0.558	0.755	-0.006 (0.099)
Income	0.208	0.120	2.999	0.083*	1.232	0.000* (0.000)
Distance to market	-0.235	0.252	0.869	0.351	0.791	-0.045 (0.055)
FTNS factors						
F1 Risks perception	-0.433	0.110	15.489	0.000***	0.649	-0.095***(0.023)
F2 Media role	0.448	0.131	11.697	0.001**	1.565	0.099**(0.028)
F3 New food technologies	0.066	0.113	0.338	0.561	1.068	0.018 (0.254)
F4 Healthy choice	-0.301	0.161	3.505	0.061*	0.740	-0.051* (0.034)
Constant	6.357	4.389	2.098	0.148	576.390	
LR X^2 (12)	40.310					
Prob >X^2	0.0003					
Pseudo R^2	0.2771					
Log Likelihood	-240.413					

Note: the dependent variable is a dummy variable: 0, not consuming packed milk; 1 consuming packed milk
***, **, * Significant at the 1%, 5% and 10% level.

technologies are unnecessary (items 4 & 9). This category has statements such as "*There is no sense trying out high-tech food products because the ones I eat are already good enough*'. The fourth component, which explained 8% of the total variance and relates to 'healthy choice motives' concerning foods produced by new food technology (items 6, 8, and 10). It contains items such as *'New food technologies is something I am uncertain about'*. and '*new food technologies can help people have a balanced diet* and *food processing technologies do not give people more control over their choices'*. Q11 and Q12 on the original 13-item FTNS statements were eliminated as they had lower factor loadings (<0.4).

The overall FTNS score for the entire sample were 3.11 (62.2 when expressed as a percentage) which is above the midpoint (Table 3), suggesting that northern Ugandan consumers had a higher degree of food technology neophobia towards packed milk products.

3.3. Influence of socio-economic & FTNS factors on processed milk consumption

To understand the influence of socio-economic and FTNS factors on consumers' decisions to consume processed milk products, a binary logistic regression model was estimated. The model included the four extracted FTNS factors and the socio-economic variables as independent variables. The estimated model had a X^2 value of 40.31 ($p< 0.003$); a log-likelihood values of 240; the Pseudo R^2 value of 0.08 suggesting that the estimated model was appropriate in predicting processed milk consumption.

Results indicate that the probability of consuming processed milk products was positively influenced by income level ($p<0.083$), suggesting that consumers with more income were more likely to purchase processed milk products; and negatively influenced by education ($P<0.043$), suggesting that educated consumers were less likely to consume processed milk products. For FTNS factors, perceived risks ($P<0.000$), and healthy choice ($P<0.061$) negatively influenced consumers' preference of processed milk products, while media role positively influenced consumer preference towards processed milk products ($P<0.001$) (Table 5).

4. Discussions

The study found that milk consumers in Northern Uganda processed a high degree of food technology neophobia towards processed milk products. Risks perceptions, media role, and healthiness percep-

Table 5
Comparison with previous FTNS-based consumer studies.

	Original study	Other applications							
	Cox and Evans (2008)	Carcciolo et al (2011)	Chen et al (2013)	Verneau et al (2014)	Coppola et al (2014)	De Steur et al (2016)	Cattaneo et al (2019)	(Cavaliere & Ventura, 2018)	This study
Neophobia factors (<FTNS statements)	1. New food technologies are unnecessary(1,2,3,4,5,6) 2. Perception of risk (7,8,9,10) 3. Healthy choice (11,12) 4. Information/media (13)	1. Risk (1,2,3,4) 2. Usefulness of technology (5,6,7,8,9) 3. Benefits and health (10,11,12) 4. Trust in media (13)	1. Perception of risk (1,2,3,4,5,6,7,8,9) 2. Healthy choice (10,11,12,13)	1. New food technologies are unnecessary (1,2,3,4,5,6) 2. perception of risks (7,8,9) 3. healthy choice (10,11,12) 4. information on media (13)	1. perceived risk (1,2,3,4) 2.Usefulness of technology (5,6,7,8,9) 3. benefits and health effects (10,11,12) 4. Trust in media (13)	1. perception of risk (2,3,4,5,7,8,9) 2. healthy choice (10,11,12,13) 3. New food technologies are unnecessary (1,4)	1. perception of risks & new food technologies are unnecessary (1,2,3,4,5,9,10,11,12) 2. Healthier choices (6,7 and 8) 3. Media role (13)	1. New food technologies are unnecessary (1,2,4,5,6) 2. Healthy choice (3,10,11,12) 3. Perception of risks (8,9,7) 4.Information/Media (13)	1. Perception of risk (1,3,5,7) 2. Media role/information (2,13) 3. New food technologies are unnecessary (4,9) 4. Healthy choice (6,8,10)
FTNS scores (%)	54	44	50	61	55	59	44	50	62

tion were the major FTNS factors determining the consumption of processed milk products. Income and education were the important socio-economic factors that influenced the consumption of processed milk products. The high level of food technology neophobia suggests that milk consumers may not easily accept to consume products they perceive to pose health risks and hence not be good for their health. This result parallels findings from (De Steur et al. 2016), which revealed a high degree of food technology neophobia amongst *Matooke* consumers in Central Uganda.

Looking at the average FTNS score of 62, Northern Ugandan consumers seems to have a similar level of food technology neophobia with Italian consumers (M = 61; (Verneau et al. 2014a), but higher than Canadians (M = 59; (Martins and Pliner 2012), Australians (M=54; (Evans et al. 2010), and Pakistanis (M = 44; (Cattaneo et al. 2019) (see comparisons in Table 5).

The high FTNS scores suggest that consumer in Northern Ugandan have a poor appreciation and understanding of milk processing technologies and associated benefits. Contextually, consumers in Northern Ugandan consumers are known for their preference for traditional local dishes. This conservativeness in food choices could explain the high level of food technology neophobia observed in this study. Because they generally trust their local milk processing methods, the introduction of new milk processing technologies leaves them in a state of worry and uncertainty about the safety of the milk produced by these new technologies. For instance, milk consumers in Northern Uganda would choose locally made yogurt called *cak lukulu* in the Luo dialect over industrially processed and packed yogurt. The reason consumers usually advance for this choice is that *cak lukulu,* which is freshly made every day is safer (free from chemicals) and tastier. Contrarily, consumers perceived the industrially processed and packed yogurt to be risky to their health since they do not understand the processes involved. Additionally, consumers believe that the preservatives used in processed and packed milk products such as UHT milk and yougurt could be harmful to their health. This finding concurs with previous observations which suggests that uncertainty associated with novel products induces a certain degree of dislike for the product (Cardello, Schutz, and Lesher 2007); (Cardello 2003; Cardello et al. 2007; Kikulwe, Wesseler, and Falck-Zepeda 2011; Verneau et al. 2014a) and this may lead to rejection of products produced by such innovative food processing technologies.

The negative influence of risk perception on packed milk consumption implies that milk consumers are risk-averse to foods produced by new technologies. Risk perception have also been reported as a key barrier to acceptance of novel food products including genetically modified (GM) foods in developing countries (Bett, Ouma, and De Groote, 2010; Frewer et al., 2013; De Steur, Buysse, Feng, & Gellynck, 2013; De Steur et al. 2010; Bett et al., 2010; Frewer et al., 2013; De Steur et al., 2010; Ueasangkomsate and Santiteerakul 2016; Ueasangkomsate and Santiteerakul 2016); and processed cooking banana in Uganda (Kikulwe et al. 2011). This suggests that developing countries consumers seems to attach more importance to the health-related aspects of food processing technologies. This high risk perception maybe explained by the need to shift from established product usage, value, image, and traditional attachments (Lafraire et al. 2016). This observation is relevant considering the fact that most milk consumers in Northern Uganda are used to and still prefer consuming locally produced milk and milk products. This is an important barrier to promotion of processed milk consumption as well as development of the dairy value chain.

The negative influence of education on packed milk consumption suggests that educated consumers could be more risk-averse and health-conscious compared to their uneducated counterparts. This observation finds credence in previous studies such as (Boccia, Covino, & Sarnacchiaro, 2018), who suggests that educated consumers attach more importance to the health-related aspects of new food products. The health consciousness of educated consumers is also due to their inherent belief that they have high levels of nutrition knowledge concerning processed

food products (Allen, Goddard, and Farmer 2018). The other plausible explanation is based on the conservative food habits of the population. As such, whether one is educated or not, they tend to want to maintain what they perceive as healthy in their tradition. Consequently, consumers might be reluctant to shift towards processed milk consumption (Barrena and Sánchez 2013).

The positive effect of income on consumption of processed milk products suggests that consumers with higher incomes were most likely to purchase processed milk products. This result can be explained by the fact that processed and packed milk products are more expensive compared to unpacked/locally processed milk. As such, only consumers with higher disposable income can afford these processed milk products. This result concurs with the previous studies such as (Chen, Anders, and An 2013) who found that income was a key determinant of consumers' assessment of products produced by novel processing technologies; () who found that income played an important role in determining the acceptance and consumption of processed *Matooke;* and (Hung, de Kok, and Verbeke 2016; Hur and Jang 2015); (Jezewska-Zychowicz and Królak 2015); (Schnettler et al., 2015) who found that income was a personal factor associated with positive consumer behavior towards functional foods such as dairy products.

The positive influence of media role could be because consumers had trust in the quality of media information provided concerning processed milk products. Specifically, consumers perceived that media provided balanced and unbiased information regarding packed milk products. The positive influence of the media is important for negating the negative influence of the perception of educated consumers that new food technologies and products can have negative health effects. This implies that aggressive investment in media promotion can lead to increased consumption of processed milk products. The significance of the media in influencing consumer choices is well illustrated by previous studies such as (Caracciolo, F Coppola, A & Verneau 2011; Cattaneo et al. 2019; Coppola et al. 2014; Verneau et al. 2014a), which provided insights into the effect that consumers' trust in media could stimulate consumer perceptions towards of food products produced by novel technologies. Therefore, to capitalize on the positive effects of the media, persuasive information needs to be provided to consumers through various approaches including television, radio stations, local newspapers, trade shows, and banners.

5. Conclusions

This paper assessed the level of food technology neophobia amongst milk consumers in northern Uganda using the food technology neophobia scale. Further, the paper assess how FTNS and socio-economic factors influence the consumption of processed milk products. The paper finds a high level of food technology neophobia amongst milk consumers, with risk perception, healthy choice, and media role as the major food technology factors. Consumer's income and education levels were the important socio-economic factors influencing the consumption of processed milk products. results of this have implication for the success of novel food processing technologies as their update maybe hindered by high levels of food technology neophobia amongst consumers. Besides food technology neophobia, we observe that culture and tradition play a critical role in influencing consumer choice when it comes to foods produced by novel processing technologies. The paper concludes that food technology neophobia, food culture and tradition are the most important factors in the success of food products produced by novel processing technologies.

A major contribution of this study lies in applying the FTNS to consumption of processed milk products in a developing country context, a setting where literature on the subject is scarce, yet very relevant in agribusiness value chain development. Promotion of new food processing technology should take into account the consumers socio-cultural contexts, as this has an influence on the food products arising from such technologies. Of particular interest is the food culture in most developing countries, where local processes are preferred over new(foreign) technologies. Results of this study therefore presents valuable information to the government and food industries in developing countries in promotion of value addition and value chain development. Its suggest that effective promotion of food processing technologies should take into account the local food culture and tradition of the target consumers.

Despite its relevance, some limitations of the study are worth noting. First, the study only focused on milk consumers in and around central business districts of Gulu and Lira cities, leaving out rural areas. Future studies could compare both rural and urban area to establish any potential variations in food technology neophobia. Second, the study looked at processed milk products in general, without differentiating the different processed products such as yoghurt, UHT, pasteurized, and cheese. Such a differentiation could reveal hidden neophobia/neophilia factors for specific processed milk products. Future research could therefore focus on assessing consumer preference for different milk processed milk products to establish potential variations in food technology neophobia and its influence on processed milk products consumption.

Declaration of Competing Interest

All the authors declare no conflict of interest and have approved this paper for submission to Applied Food Research

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References

Achan J. (2018, June 28). Increased milk production with low consumption. The new vision. Kampala Edition. Retrieved from *https://www.newvision.co.ug* › newvision › news › uganda-increases-milk.

Allen, S., Goddard, E. &., & Farmer, A. (2018). How knowledge, attitudes, and beliefs impact dairy anti-consumption. *British Food Journal.* 10.1108/BFJ-12-2017-0733.

Balikowa, D. (2011). *Dairy Development in Uganda. A Review of Uganda's Dairy Industry. Vol. 3202. Kampala.*

Barrena, R., & Sánchez, M. (2013). 'Neophobia, Personal Consumer Values and Novel Food Acceptance. *Food Quality and Preference, 27*(1), 72–84. 10.1016/j.foodqual.2012.06.007.

Bett, C., Ouma, J. O., & De Groote, H. (2010). Perspectives of gatekeepers in the Kenyan food industry towards genetically modified food. *Food Policy, 35*(4), 332–340. 10.1016/j.foodpol.2010.01.003.

Boccia, F., Covino, D., & Sarnacchiaro, P. (2018). Genetically modified food versus knowledge and fear: A Noumenic approach for consumer behaviour. *Food research international, 111*, 682–688.

Bureau.Statistics. (2017). Uganda Bureau of Statistics 2017 Statistical Abstract. *Uganda.*

Caracciolo, F., Coppola, A. & Verneau, F. 2011. 'Validation of a Psychometric Scale to Measure Consumers' Fears of Modern Food Technologies'. (N0. 1019-2016-81698):160–74.

Cardello, Armand V. (2003). Consumer concerns and expectations about novel food processing technologies : Effects on product liking. *Appetite, 40*(3), 217–233. 10.1016/S0195-6663(03)00008-4.

Cardello, Armand V, Schutz, Howard G., & Lesher, Larry L. (2007). Consumer perceptions of foods processed by innovative and emerging technologies : A conjoint analytic study. *Innovative Food Science and Emerging Technologies, 8*(1), 73–83. 10.1016/j.ifset.2006.07.002.

Cattaneo, C., Lavelli, V., Proserpio, C., &. Laureati, M., & Pagliarini, E. (2019). 'Consumers' attitude towards food by-products: The influence of food technology neophobia, education and information. *International Journal of Food Science & Technology, 54*(3), 679–687. 10.1111/ijfs.13978.

Chen, M. F. (2008). An integrated research framework to understand consumer attitudes and purchase intentions toward genetically modified foods. *British Food Journal, 110*(6), 559–579. 10.1108/00070700810877889.

Chen, Q., Anders, S., & An, H. (2013). Measuring Consumer Resistance to a New Food Technology: A Choice Experiment in Meat Packaging. *Food Quality and Preference, 28*(2), 419–428. 10.1016/j.foodqual.2012.10.008.

Chen, Q., Anders, S., & An, H. (2013). Measuring consumer resistance to a new food technology: A choice experiment in meat packaging. *Food Quality and Preference, 28*(2), 419–428.

Coppola, A., &. Verneau, F., & Caracciolo, F. (2014). 'Neophobia in Food Consumption : An Empirical Application of the FTNS Scale in Southern Italy. *Italian Journal of Food Science, 26.*

Cox, D. N., & Evans, G. (2008). Construction and Validation of a Psychometric Scale to Measure Consumers' Fears of Novel Food Technologies: The Food Technology Neophobia Scale. *Food Quality and Preference, 19*(8), 704–710. 10.1016/j.foodqual.2008.04.005.

De Steur, H., Odongo, W., & Gellynck, X. (2016). Applying the food technology neophobia scale in a developing country context. A case-study on processed matooke (cooking banana) flour in Central Uganda. *Appetite, 96*, 391–398.

De Steur, H., Buysse, J., Feng, S., & Gellynck, X. (2013). Role of Information on Consumers' Willingness-to-pay for Genetically-modified Rice with Health Benefits: An Application to C hina. *Asian Economic Journal, 27*(4), 391–408.

De Steur, H., Gellynck, X., Storozhenko, S., Liqun, G., Lambert, W., &. Van DerStraeten, D., & Viaene, J. (2010). Willingness-to-Accept and Purchase Genetically Modified Rice with High Folate Content in Shanxi Province, China'. *Appitite, 54*(1), 118–125. 10.1016/j.appet.2009.09.017.

De Steur, H., Odongo, W., & Gellynck, X. (2016). Applying the Food Technology Neophobia Scale in a Developing Country Context. A Case-Study on Processed Matooke (Cooking Banana) Flour in Central Uganda. *Appetite, 96*, 391–398. 10.1016/j.appet.2015.10.009.

Evans, G., Kermarrec, C., Sable, T., & Cox, D. N. (2010). Reliability and Predictive Validity of the Food Technology Neophobia Scale. *Food and Nutrition Sciences, 54*(2), 390–393. 10.1016/j.appet.2009.11.014.

X Frewer, L. J., Van der Lans, I. A., Fisher, A. R., Reinders, M. J., Menozzi, D, Zhang, L, & Zimmermann, K (2013). Public Perceptions of Agri-Food Applications of Genetic Modification e A Systematic Review and Meta-Analysis'. *Trends in Food Science & Technology, 30*(2), 142–152. 10.1016/j.tifs.2013.01.003.

Frewer, L. J., Bergmann, K., Brennan, M., Lion, R., Meertens, R., Rowe, G., & Vereijken, C. M. J. L. (2011). Consumer Response to Novel Agri-Food Technologies : Implications for Predicting Consumer Acceptance of Emerging Food Technologies. *Trends in Food Science & Technology, 22*(8), 442–456. 10.1016/j.tifs.2011.05.005.

Frewer, L. J., Gupta, N., George, S., Fischer, A. R. H., &. Giles, E. L., & Coles, D. (2014). Consumer Attitudes towards Nanotechnologies Applied to Food Production. *Trends in Food Science and Technology, 40*(2), 211–225. 10.1016/j.tifs.2014.06.005.

Gliem, J. A., & Gliem, R. R. (2003). Calculating, Interpreting, and Reporting Cronbach ' s Alpha Reliability Coefficient for Likert-Type Scales. *Midwest Research-to-Practice Conference in adult, Continuing, and Community Education*.

Hung, Y., de Kok, T. M. &., & Verbeke, W. (2016). Consumer Attitude and Purchase Intention towards Processed Meat Products with Natural Compounds and a Reduced Level of Nitrite. *Meat Science, 121*, 119–126. 10.1016/j.meatsci.2016.06.002.

Hur, J. &., & Jang, S. S. (2015). Anticipated Guilt and Pleasure in a Healthy Food Consumption Context. *International Journal of Hospitality Management, 48*, 113–123. 10.1016/j.ijhm.2015.04.015.

Jezewska-Zychowicz, M. &., & Królak, M. (2015). Do Consumers' Attitudes Towards Food Technologies and Motives of Food Choice Influence Willingness to Eat Cereal Products Fortified with Fibre? *Polish Journal of Food and Nutrition Sciences, 65*(4), 281–291. 10.2478/pjfns-2013-0014.

Kikulwe, E. M., Wesseler, J. &., & Falck-Zepeda, J. (2011). Attitudes, Perceptions, and Trust. Insights from a Consumer Survey Regarding Genetically Modified Banana in Uganda. *Appetite, 57*(2), 401–413. 10.1016/j.appet.2011.06.001.

Lafraire, J., Rioux, C., Giboreau, A., & Picard, D. (2016). Food Rejections in Children : Cognitive and Social /Environmental Factors Involved in Food Neophobia and Picky/ Fussy Eating Behavior. *Appetite, 96*, 347–357. 10.1016/j.appet.2015.09.008.

Martins, I. B. A., Oliveira, D., &. Rosenthal, G., Ares, A, & Deliza, R. (2019). Brazilian Consumer's Perception of Food Processing Technologies: A Case Study with Fruit Juice. *Food Research International, 125*(108555). 10.1016/j.foodres.2019.108555.

Martins, Y., & Pliner, P. (2012). Human Food Choices : An Examination of the Factors Underlying Acceptance /Rejection of Novel and Familiar Animal and Nonanimal Foods. *Appetite, 45*(3), 214–224. 10.1016/j.appet.2005.08.002.

McKenzie, Kirsty, Metcalf, Debra Ann, & Saliba, Anthony (2021). Validation of the Food Technology Neophobia Scale in a Chinese Sample Using Exploratory and Confirmatory Factor Analysis. *Food Quality and Preference, 89*, Article 104148.

Naing, L., Winn, T., & Rusli, B. N. (2006). Practical Issues in Calculating the Sample Size for Prevalence Studies. *Archives of Orofacial Sciences, 1*, 9–14.

Rollin, F., Kennedy, J. &., & Wills, J. (2011). Consumers and New Food Technologies. *Trends in Food Science and Technology, 22*(2–3), 99–111. 10.1016/j.tifs.2010.09.001.

Ronteltap, A., Van Trijp, J. C. M., &. Renes, R. J., & Frewer, L. J. (2007). Consumer Acceptance of Technology-Based Food Innovations : Lessons for the Future of Nutrigenomics. *Appetite, 49*(1), 1–17. 10.1016/j.appet.2007.02.002.

Sahu, M. &., & Bala, S. (2017). Food Processing, Food Spoilage and Their Prevention : An Overview'. *Int. J. Life Sci. Scienti Res, 3*(1), 753–759. 10.21276/ijlssr.2017.3.1.1.

Schnettler, B., Miranda, H., Lobos, G., Orellana, L., Sepúlveda, J., Mora, M., & Grunert, K. (2015). Eating habits and subjective well-being. A typology of students in Chilean state universities. *Appetite, 89*, 203–214.

Siegrist, Michael. (2008). Factors Influencing Public Acceptance of Innovative Food Technologies and Products. *Trends in Food Science & Technology, 19*(11), 603–608. 10.1016/j.tifs.2008.01.017.

Sonne, Anne-Mette, Grunert, Klaus G., Olsen, Nina Veflen, Granli, Britt-Signe, Szabó, Erzsébet, & Banati, Diana (2012). 'Consumers' Perceptions of HPP and PEF Food Products. *British Food Journal, 114*(1), 85–107.

Ueasangkomsate, Pittawat, & Santiteerakul, Salinee (2016). A Study of Consumers ' Attitudes and Intention to Buy Organic Foods for Sustainability. *Procedia Environmental Sciences, 34*, 423–430. 10.1016/j.proenv.2016.04.037.

Verneau, F., Caracciolo, F., Coppola, A., & Lombardi, P. (2014a). Consumer Fears and Familiarity of Processed Food. The Value of Information Provided by the FTNS'. *Appetite, 73*, 140–146. 10.1016/j.appet.2013.11.004.

Verneau, F., Caracciolo, F., Coppola, A., & Lombardi, P. (2014b). Consumer Fears and Familiarity of Processed Food . The Value of Information Provided by the FTNS q'. *Appetite, 73*, 140–146. 10.1016/j.appet.2013.11.004.

Walther, B., Wechsler, D., Schlegel, P., & Haldimann, M. (2018). Iodine in Swiss milk depending on production (conventional versus organic) and on processing (raw versus UHT) and the contribution of milk to the human iodine supply. *Journal of Trace Elements in Medicine and Biology, 46*, 138–143.