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Applying the food technology neophobia scale in a developing country context. A case-study on processed *matooke* (cooking banana) flour in Central Uganda

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ABSTRACT

The success of new food technologies largely depends on consumers' behavioral responses to the innovation. In Eastern Africa, and Uganda in particular, a technology to process *matooke* into flour has been introduced with limited success. We measure and apply the Food technology Neophobia Scale (FTNS) to this specific case. This technique has been increasingly used in consumer research to determine consumers' fear for foods produced by novel technologies. Although it has been successful in developed countries, the low number and limited scope of past studies underlines the need for testing its applicability in a developing country context. Data was collected from 209 *matooke* consumers from Central Uganda. In general, respondents are relatively neophobic towards the new technology, with an average FTNS score of 58.7%, which hampers the success of processed *matooke* flour. Besides socio-demographic indicators, 'risk perception', 'healthiness' and the 'necessity of technologies' were key factors that influenced consumer's preference of processed *matooke* flour. Benchmarking the findings against previous FTNS surveys allows to evaluate factor solutions, compare standardized FTNS scores and further lends support for the multidimensionality of the FTNS. Being the first application in a developing country context, this study provides a case for examining food technology neophobia for processed staple crops in various regions and cultures. Nevertheless, research is needed to replicate this method and evaluate the external validity of our findings.

1. Introduction

Despite the high rate of market failures, new food technologies are still increasingly introduced, due to the anticipated range of benefits they can bring to the consumer and the food sector, particularly in developing regions (Rollin, Kennedy, & Wills, 2011). Nevertheless, consumers are traditionally concerned about the risks associated with such food applications, especially when there is a perceived lack of tangible benefits (Frewer et al., 2011; Rollin et al., 2011; Siegrist, 2008). This has led to a growing body of literature in consumer food research dealing with consumers' fear of novel foods, also known as food neophobia (e.g. Caracciolo, Coppola, & Verneau, 2011; Chen, Anders, & An, 2013; Coppola, Verneau, & Caracciolo, 2014; Cox & Evans, 2008; Frewer et al., 2011; Matin et al., 2012; Pliner & Hobden, 1992; Siegrist, 2008; Verneau, Caracciolo, Coppola, & Lombardi, 2014). While it is generally characterized as a personality trait, i.e. a continuum along which people can be placed in terms of their tendency to be in favor of new foods or to be reluctant (Pliner & Salvy, 2006), food neophobia has also been treated as a form of behavior, involving the avoidance of novel foods in particular situations (Pliner & Salvy, 2006; Ritchey, Frank, Hursti, & Tuorila, 2003). As the success of new food technologies largely hinge on consumers' behavioral responses in the market place (Chen et al., 2013), negative attitudes towards food technologies may prevent widespread adoption and result into product failures. Therefore, identifying population segments that are more or less food technology neophobic as well as segments of early adopters of innovative food technology is deemed useful from a marketing point of view (Evans, Kermarrec, Sable, & Cox, 2010).

Food neophobia does not only relate to consumers' reluctance to

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try new food products, but also to the acceptance of new technologies used in food production and processing, known as food technology neophobia (e.g. Bäckström, Pirttilä-Backman, & Tuorila, 2004; Choe & Cho, 2011; Cox & Evans, 2008; Grunert, Bredahl, & Scholderer, 2003; Lähteenmäki et al., 2002). Therefore it is deemed useful to make a distinction between the acceptance of new foods and the new technologies that are applied to develop those foods (Evans et al., 2010; Frewer et al., 2011; Grunert et al., 2003; Siegrist, 2008). The key factors that contribute to consumers' resistance to try foods produced by new food technologies generally include functional barriers related to ease of use and usefulness, benefits and risk perceptions, knowledge and attitudes, socio-demographic indicators and lifestyle factors, as well as psychological barriers (Chen et al., 2013; Frewer et al., 2013; Ronteltap, Van Trijp, Renes, & Frewer, 2007).

When looking at consumer research on food and food technology neophobia, the development of the Food Neophobia Scale (FNS) (Pliner & Hobden, 1992), which provides a standardized, validated measurement, is considered as the starting point for the increased attention on both phenomena, by which scientists particularly focused on evaluating the relationship between appetite and food aversion (Choe & Cho, 2011; Olabi, Najm, Baghdadi, & Morton, 2009). The FNS has been found to be associated with general neophobia, trait anxiety and sensation seeking (Pliner & Hobden, 1992). Consequently, studies have shown that the FNS accurately predicts responses to novel or unfamiliar food (e.g. Lähteenmäki et al., 2002; Ritchey et al., 2003).

However, while the FNS has been proven to be suitable for assessing consumer reactions towards ethnic or other culture foods (Pliner & Hobden, 1992), it seems not appropriate for examining acceptance of foods produced by novel technologies (Cox & Evans, 2008; Frewer et al., 2011; Siegrist, 2008). Even though food technology neophobia is still poorly addressed in consumer research (Choe & Cho, 2011; Cox & Evans, 2008; Olabi et al., 2009), the Food Technology Neophobia Scale (FTNS) (Cox & Evans, 2008; Evans et al., 2010), is considered a more suitable tool than the food neophobia scale (FNS) (Pliner & Hobden, 1992) to map consumer perceptions of food technologies. The original FTNS consists of 13 seven-point bi-polar scales, anchored from 'totally disagree' to 'totally agree' with a neutral mid-point, which focus on food technology itself, rather than the (attributes of the) food product.

Since its introduction in 2008, seven consumer studies have measured the FTNS (for a review, see Table 1). Building upon the first application of Cox and Evans (2008), Evans et al. (2010) have retested the FTNS constructs by looking at the same processing technologies, products and research location as in their original work. Out of the remaining studies, two focused on food packaging in Canada (Chen et al., 2013; Matin et al., 2012), while three other studies applied FTNS to food processing in Italy (Caracciolo et al., 2011; Coppola et al., 2014; Verneau et al., 2014). In general, the FTNS has been shown to be a valid and reliable measure of food technology neophobia. Although it has been tested and lauded for its consistency and stability (e.g. Chen et al., 2013; Evans et al., 2010; Matin et al., 2012; Verneau et al., 2014), the low number and limited scope of FTNS applications do not allow validation of its use in different contexts. Firstly, the existing FTNS studies have only been conducted in developed countries, such as Australia (Cox & Evans, 2008; Evans et al., 2010), Canada (Chen et al., 2013; Matin et al., 2012) and Italy (Caracciolo et al., 2011; Coppola et al., 2014; Verneau et al., 2014). Secondly, besides the work of Cox and Evans, two other studies (Chen et al., 2013; Matin et al., 2012) also dealt with food-related packaging technology, rather than focusing on food technology. Consequently, there is a need to conduct more studies on the applicability of the FTNS in other sectors and contexts, especially in relation to food technology in developing regions.

Indeed, consumers have heterogeneous attitudes and preferences toward different, novel food technologies (Frewer et al., 2013; Pliner & Salvy, 2006; Ronteltap et al., 2007), which may affect their food choices. This study measures and applies the FTNS to assess consumer preference of *matooke* (fresh versus processed) in Uganda. *Matooke* is an East-African highlands cooking banana that is traditionally peeled, mashed and boiled or steamed in banana leaves after being harvested between three-quarters to full maturity (Florence Isabirye Muranga, Sampath, Marlett, & Ntambi, 2007). During this process, the color of the pulp changes from a creamy white to a yellowish color depending on original maturity of the bunch. Because *matooke* fruit is bulky and highly perishable, post-harvest losses are consistently high, up to a level of 45% (Florence I Muranga, Mutambuka, Nabugoomu, & Lindhauer, 2010; Florence I Muranga, Nabugoomu, & Katebarirwe, 2011). To substantially reduce the bulk of *matooke* starch, increase its shelf-life and diversify its use for bakery and confectionary industries, recent advances in processing (pre-gelatinization) have resulted in the development of banana flours, like raw, instant and extruded 'Tooke' flour (Florence I Muranga et al., 2011).

With banana as its main staple crops, Uganda also became one of the world's largest producers of *matooke*, ranking first in Sub-Saharan Africa, with an estimated production of about 9.5 million tons (i.e. 26.4% of the global production), cultivated by 72% of farmers (Karugaba & Kimaru, 1999). While Uganda also has the highest per capita consumption of *matooke*, estimated at 191 kg per year, *Tooke* flour was less successful. Since its introduction in 2008, processed banana flour only obtained a market share between 20% and 30% (Florence I Muranga et al., 2010). The low adoption of the *Tooke* flour raises a food technology neophobia question. Emerging processed food products based on novel technologies sometimes tend to raise concerns amongst consumers, who perceive them as unsafe, unnatural and unpleasant, hence the need for applying the FTNS to the case of processed *matooke* (Cooking Banana) flour.

2. Materials and methods

2.1. Data collection method

By using convenience sampling, a sample was drawn from banana consumers in the central business districts of Kampala, Wakiso and Mukono in Central Uganda. The majority of the population in these areas are traditional *matooke* consumers. These are also locations where 'Tooke' flour has been introduced.

Based on a pretested, structured questionnaire, face-to-face interviews were administered between April and May 2013. Out of the 220 respondents who completed the questionnaires, 209 questionnaires were considered useful for further analysis. Therefore, four enumerators were hired and trained specifically for the purpose of the data collection. Respondents were briefed on the nature and context of the study. Even though all of them knew what *matooke* is, each enumerator carried a packet of the *Tooke* flour for each interview session to ensure that respondents do not mistake the *Tooke* flour for other types of flour.

The survey questionnaire was structured into two major parts. The first section focused on the socio-demographic profile of the respondents. The following indicators were included: gender, age, marital status, household size, income level, education level, employment status and distance to the market. The second part assessed respondents' attitudes towards food technology using the 13-item FTNS scale as validated in various studies (Chen et al., 2013; Evans et al., 2010; Verneau et al., 2014). The various statements, measured on a 5-point Likert scale (degree of agreement/disagreement), refer to perceptions about new food technologies,

Table 1
Overview of studies applying the Food Technology Neophobia Scale (FTNS) in consumer research.

	Author(s)	Country	Objective	Sample size	Data collection method	FTNS measurement	Product	Technology	Neophobia factors
1	Cox and Evans (2008)	Australia	Development of a psychometric tool that identifies food technology neophobia among consumers	$N_1 = 193$ $N_2 = 450$	Standardized two stage survey	7-point Likert Scale	• Fruit juice • Prawns • Oilseeds • Yoghurt	• Pasteurization of fruit juice • High pressure processing of fruit juice, • Modified atmosphere packaging of salads • Triploidy of prawns • Genetic modification of oil seeds • Bioactive yoghurt	• New food technology are unnecessary • Perception of risk • Healthy choice • Information/ media
2	Evans et al. (2010)	Australia	Further testing of the FTNS	N = 131	Standardized survey using 'willingness to try' new foods	7-point Likert Scale	• Fruit juice • Prawns • Oilseeds • Yoghurt	• Pasteurization of fruit juice Bioactive yoghurt • Fortification • Selective breeding • Triploidy • Genetic modification • Nanotechnology	
3	Caracciolo et al. (2011)	Italy	Validation of the FTNS	N = 355	Standardized survey	7-point Likert Scale	• Organic foods • Functional foods • Light products • Light products • Frozen and Ready to eat products, • Typical products and Short chain products	• Food processing	• Perceived risk • Usefulness of technology component • Benefits and health effects • Trust in media role
4	Matin et al. (2012)	Canada	Measure attitudes towards nanotechnology	N = 777	Standardized survey	5-point Likert Scale	• Food	• Nanotechnology packaging	• Neophobia on a summated scale
5	Chen et al. (2013)	Canada	Assess consumer perceptions and estimates of WTP vacuum packaging	N = 99	Choice experiments & standardized survey	5-point Likert Scale	• Beef	• Vacuum packaging	• Risk perceptions • Food safety concerns
6	Verneau et al. (2014)	Italy	Understanding neophobia and neophilia factors affecting food choices	N = 555	Standardized survey	7-point Likert Scale	• Fat reduced food • Enriched drinks and yoghurt • Ready to eat frozen food	• Food processing	• Perceived need for new food technology Perception of risk • Healthy choice • Information/ media
7	Coppola et al. (2014)	Italy	Analyzing the relationship between attitude toward food technologies, intention and behavior	N = 355	Standardized survey	7-point Likert Scale	• Organic foods • Functional foods • Light products • Light products • Frozen and Ready to eat products, • Typical products and short chain products	• Food processing	• Perceived risk • Usefulness of technology component • Benefits and health effects • Trust in media role

their benefits and associated risks.

2.2. Data analysis

Data was entered and analyzed using SPSS version 21.0 and AMOS 21. Exploratory Factor Analysis (EFA) was used to examine the respondents' perceptions of novel food technologies, as derived from the 13 original FTNS statements, with a theoretical range of 13–65. The use of EFA is justified because there are at least ten times as many respondents for every variable and the absolute sample size is greater than 100 (Janssens, Wijnen, De Pelsmacker, & Van Kenhove, 2008). Exploratory factor analysis using Principal Components Analysis (PCA) with Varimax rotation was conducted to determine the most appropriate factor solution. Thereby, four FTNS questions (Q10,11,12 and 13) were reversed. The Kaiser–Meyer–Olkin (KMO) Measure of Sampling Adequacy was 0.804 and the Bartlett's Test of Sphericity was 859.359 ($p < 0.000$), both reflecting that it is meaningful to perform a factor analysis on the dataset.

Cronbach's alpha internal consistency test was used to justify the development of a composite variable for each of the factors. To further understand the underlying dimensions of the consumer perceptions towards new food production technologies, we have measured the correlation coefficients between the FTNS (factors and overall score) and the socio-demographic variables. A logistic regression model was run to estimate the effect of the established FTNS factors and socio-demographic variables on consumer preference of processed *matooke* flour. The latter, i.e. the dependent

variable, is a dummy variable (0: only consuming fresh banana; 1: consuming processed *matooke* flour alone or in combination with fresh *matooke*), that is derived from questions related to self-reported consumption of both types of *matooke* in the last 7 days.

3. Results

3.1. Sample descriptive

The socio-demographic profile of the sample indicates that males are slightly more presented (58% of participants), while the average age was about 32 years. In general, respondents were married (71%) and were formally employed (69%), while having an average household size of 6 persons and had a degree or secondary level of education (85%). When comparing these figures with national census data, our sample has 8.4% more males, a larger household size (5.5 versus 4.7 persons), but a similar level of employed people (UBOS., 2014; UBOS & ICF International, 2012). As expected, most participants consumed *matooke* bananas in a fresh form (83%).

3.2. Food technology neophobia scale

The overall FTNS score of the entire sample was 3.34 on a 5-point Likert scale, slightly above the midpoint, or 58.65%, when expressed as a percentage (Table 2). As individuals who are less likely to try (more likely to refuse) foods produced by new food technologies having a significantly higher score on the FTNS, this score reflects a moderate degree of neophobia towards food technology, but high in comparison with previous studies (see further).

3.2.1. Exploratory factor analysis (EFA)

The results of the EFA, both the factor loadings and the communalities, are summarized in Table 3. The 13 FTNS questions loaded well on one of the three FTNS factors (loadings >0.4), which together explain 58.66% of the variance in the variables on consumer perceptions towards new food technologies. This demonstrates the applicability of the FTNS in our sample of *matooke* consumers in a developing country context.

Factor 1 relates to the 'perception of risks' of foods produced by new food technologies and contains six items, such as '*New food technologies decreases the natural quality of food, New foods are not healthier than traditional foods*'. Factor 2 relates to 'healthy choice motives' concerning foods produced by new food technology (5 items). It contains items such as '*new food technologies are unlikely to have long term negative health effects and New food technologies gives people more control over their food choices**'. Factor 3 relates to the perception that 'new food technologies are unnecessary' (2 items). 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*', *and 'There are plenty of tasty foods around so we don't need to use new food technologies to produce more'*. Given the high values of the Cronbach's Alpha test for internal reliability (>0.6), we develop a composite variable for factor 1 (6 items), factor 2 (5 items) and factor 3 (2 items).

3.2.2. FTNS and its relationship with socio-demographic variables

Table 4 presents the correlation coefficients between FTNS, both the factors and the overall score, and metric socio-demographic variables. Regarding the overall FTNS score, a higher degree of food technology neophobia is associated with a higher age, a larger household, a lower education level and higher income level. Significant negative correlations were found between education level and factors 'Risk perception' and 'New food technologies are unnecessary'. The more education a consumer receives, the less he/she views new food technology as being risky or necessary. Age was positively correlated with the factor 'New food technologies are unnecessary', suggesting that older people tend to perceive new food technologies as being unnecessary. Factor 2 'Healthy choices' was only significantly correlated with the number of people in the household. Larger households, i.e. respondents with a large number of children, seem to be more concerned with the healthiness of the food consumed at home. Finally, the higher the monthly income, the more attention someone pays to risk that is associated with consuming foods produced by novel technologies. A t-test for gender did not reveal any significant differences in FTNS factor scores between males and females.

3.2.3. Comparison of FTNS-based studies: overall FTNS and factor solutions

Table 5 compares the factor solutions and the overall FTNS score (in percentage), of each FTNS-based consumer study, if available. Factor solutions differ between 2 and 4 factors. While most of the factors, such as 'risk perception', 'new food technologies are unnecessary', 'benefits and health effects' or 'healthy choice', 'trust in media' or 'information on media', appear in several studies, the statements that are assigned to these factors are often different.

When looking at the overall FTNS scores, which vary between 49.9% (Canada) and 61.4% (Italy) (Verneau et al., 2014), our sample obtains the second highest value of food technology neophobia. In other words, the population of *matooke* consumers from Uganda generally tends to be neophobic towards the use of technology in food.

Table 2
Descriptive statistics of the sample.

Variable	Description	Mean	Percentage	Std. dev
Gender	1 = Male, 0 = female		57	0.496
Age	Age of respondents in complete years	31.6		9.446
Marital status	1 = married, 0 = otherwise		71	0.456
Household size	Number of people living in the household	5.50		3.631
Education	Number of years spent in school	12.89		4.497
Income	Total monthly income (UgShs)	460,813.40[a]		350,079.80[a]
Occupation	1 = Employed; 0 = otherwise		69	0.462
Market distance	Average distance to the market	2.41		2.41
Banana consumption	Form in which banana is consumed in the household			
Fresh			83.3%	
Processed			6.2%	
Both			10.5%	
FTNS	Overall score on the Food Technology Neophobia Scale	3.34[b]	58.65	0.605

[a] US$1 is about 2550 UgShs (Ugandan Shillings).
[b] Based on a 5-point Likert scale.

Table 3
Factor loadings of food neophobia using principle component analysis.

FTNS items		Mean	Std. Dev	F1	F2	F3	Communalities
1	There are plenty of tasty foods around so we don't need to use new food technologies to produce more.	2.96	1.298	0.181	0.014	**0.875**	0.799
2	The benefits of new food technologies are often grossly overstated.	3.55	1.143	**0.688**	0.006	0.283	0.554
3	New food technologies decreases the natural quality of food.	3.51	1.175	**0.634**	0.082	0.340	0.524
4	There is no sense trying out high-tech food products because the ones I eat are already good enough.	2.86	1.129	0.288	0.259	**0.734**	0.689
5	New foods are not healthier than traditional foods	3.60	1.44	**0.730**	0.058	0.135	0.555
6	New foods technologies are something I am uncertain about	3.40	1.285	0.346	**0.453**	0.321	0.428
7	Society should not depend heavily on technology to solve its food problems	3.56	1.003	**0.722**	0.293	0.104	0.618
8	New food technologies may have long term negative environmental effects	3.44	1.028	**0.693**	0.004	0.033	0.481
9	It can be risky to switch to new food technologies too quickly	3.11	1.11	**0.732**	0.028	0.308	0.632
10	New food technologies are unlikely to have long term negative health effects[R]	3.34	1.012	0.099	**0.794**	0.248	0.701
11	New products produced by using new food technologies can help people have a balanced diet[R]	3.11	1.110	0.139	**0.670**	0.307	0.563
12	New food technologies gives people more control over their food choices[R]	3.18	1.094	0.259	**0.719**	0.079	0.590
13	The media usually provides a balanced and unbiased view of new technologies[R]	3,54	1156	0.004	**0.604**	0.357	0.492
Percentage variance explained (58.66%)				25.22	17.93	15.52	
Cronbach's Alpha internal reliability (bold variables)				0.818	0.682	0.777	

F1 = Perception of risk; F2 = Healthy choice; F3 = New food technologies are unnecessary.
[R]means item is reversed scored.
Note: KMO measure of sampling adequacy: 0.804; Bartlett's test of Sphericity 859.359(p = 0.000); Loadings > 0.4 are highlighted.

Table 4
Correlations between the FTNS factors and socio-demographic variables, correlation coefficients and significance level.

FTNS factor	Age (years)	Household size	Education level	Monthly income
F1 Risk perception	0.113	0.029	−0.146*	0.136*
	(0.103)	(0.672)	(0.035)	(0.049)
F2 Healthy choices	0.120	0.277***	−0.082	0.133
	(0.083)	(0.00)	(0.237)	(0.055)
F3 New food technologies are unnecessary	0.175	−0.066	−0.194**	0.022
	(0.11)	(0.341)	(0.005)	(0.752)
FTNS	0.179**	0.156*	−0.206**	0.183*
	(0.010)	(0.025)	(0.003)	(0.008)

*, **, *** Correlation coefficient is significant at 0.05, 0.01 and 0.001 level, respectively.
Note: p-values are presented in between brackets.

3.2.4. *Explaining processed matooke flour consumption through food technology neophobia and socio-demographic variables*

To understand which factors influence consumers decisions to choose processed *matooke* flour, alone or in combination with fresh *matooke*, we have estimated a binary logistic regression model (Table 6). The model included both the 3 FTNS factors as well as socio-economic variables as independent variables.

Our results indicate that the probability of consuming processed *matooke* flour was positively influenced by the distance to the market (p = 0.020) and the income level (p = 0.004), while marital

Table 5
Comparison of the factor analysis results with previous FTNS-based consumer studies.

	Original study	Other applications					This study
	Cox and Evans (2008)	Caracciolo et al. (2011)	Chen et al. (2013)	Verneau et al. (2014)	Coppola et al. (2014)	Matin et al. (2012)	
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. Uselessness of technology (5,6,7,8,9) 3. Benefits and health effects (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 risk (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)
FTNS score (%)	53.85	/	49.94	61.41	/	55.38	58.65

FTNS, Food Technology Neophobia Scale.
Note: Numbers between brackets refer to FTNS statements (see Table 4). The characteristics of the studies used for comparison are presented in Table 1.
[a] Due to differences in measurement (5-point versus 7-point Likert Scale), the original mean FTNS scores were standardized and expressed as percentages.

Table 6
The effect of socio-demographic variables and the FTNS factors on consumer preference of processed *matooke* flour, by binary logistic regression.

Variable	B	SE	Wald	Significance	Exp(B)
Socio-economic factors					
Gender (1 = male)	0.050	0.479	0.011	0.917	1.051
Age	−0.046	0.033	1.864	0.172	0.955
Marital status (1 = married)	−1.273	0.620	4.213	0.040[a]	0.280
Household	−0.102	0.079	1.659	0.198	0.903
Education level	−0.004	0.061	0.005	0.946	0.996
Employment status(1 = employed)	−0.549	0.639	0.738	0.390	0.577
Income	0.000	0.000	8.455	0.004[c]	1.000
Distance to market	0.212	0.091	5.413	0.020[b]	1.237
FTNS factors					
F1 Perception of risks	−1.046	0.329	10.097	0.001[c]	0.351
F2 Healthy choices	−0.817	0.294	7.738	0.005[c]	0.442
F3 New food technologies are unnecessary	0.174	0.259	0.451	0.502	1.190
Constant	4984	1993	6.252	0.012	146.064

Nagelkerke R^2: 0.343; Cox and Snell R^2: 0.204.
Note: Dependent variable is a dummy variable: 0, only consuming fresh banana; 1: consuming processed *matooke* flour alone or in combination with fresh matooke.
[a] Significant at the 0.05 level.
[b] Significant at the 0.01 level.
[c] Significant at the 0.001 level.

status ($p = 0.040$) had a significant, negative influence. This is most likely due to negative price perceptions of processed *matooke* flour, as compared to the fresh ones. The effect of marital status on the consumption is likely to be related to the traditional perceptions of *matooke* as a staple food in Uganda. Given the high food demands of Ugandan households, with an average size of 6 persons, and the general perception that processed *matooke* flour is an expensive product, married couples will more likely prefer the cheaper fresh banana over the processed bananas. Consequently, low income consumers will more likely prefer to consume only fresh banana.

For the FTNS factors, 'perception of risk' ($p = 0.001$) and 'healthy choice' ($p = 0.005$) negatively influenced consumers preference of processed *matooke* flour. The negative influence of healthy choice motives is also consistent with previous studies, where the uncertainty associated with novel products induced a certain degree of dislike among consumers (Cardello, 2003; Verneau et al., 2014). Kikulwe, Wesseler, and Falck-Zepeda (2011), for instance, also demonstrated that higher benefit perceptions increased the likelihood of purchasing Genetically Modified (GM) banana, while higher risk perceptions were associated with a lower intention to purchase GM banana. The significant effect of a health related FTNS factor was also found in previous FTNS-based studies (Kikulwe et al., 2011; Verneau et al., 2014). Another argument for the impact of FTNS on the preference of processed *matooke* flour, hence the success of its introduction, is found when comparing the overall FTNS score between the two groups. As expected, those who do not consume any processed *matooke* flour have a significantly higher degree of food technology neophobia (44.69 as compared to 35.86) (t-test: 7.51; $p < 0.001$).

4. Discussion

While seven consumer studies already applied the FTNS, the present FTNS-based study is innovative in several ways. It is the first study that (1) used the FTNS in a developing country context, i.e. Uganda; (2) targeted towards the use of food technology in a traditional, staple crop, i.e. processed *matooke* flour; (3) examined differences in FTNS factors according to the socio-demographic variables and the role of the FTNS in explaining preference of technology-based food; (4) reviewed the literature in order to benchmark the findings against the previous studies, e.g. by using standardized FTNS scores and evaluating the different factor solutions.

Our results showed that Ugandan consumers are characterized by a high degree of neophobia towards novel food technologies, especially when compared with the overall FTNS scores of the previous FTNS-based studies. Although the specific characteristics of the data collection and sampling method also might account for this, the present study can be considered as a first indication that the success of new technologies in Africa, and banana processing technology in particular, may be hampered by consumers' neophobia.

We conducted an EFA in order to identify a factor solution for our specific sample of Ugandan banana consumers. Based on the EFA, the FTNS items should be categorized into three technology neophobia factors related to risk perceptions, healthy choices and the necessity of new technologies. When compared to other FTNS studies, the 3-factor solution in Uganda shows as much similarities as dissimilarities with the factor solutions of previous FTNS-based studies (Table 5). While the way FTNS items are combined in our study is very similar to the Italian (Verneau et al., 2014) and Canadian study (Chen et al., 2013), especially with respect to 'risk perceptions' and 'healthy choices', our results did not support the inclusion of a separate factor for the 'role of media' like most of the studies. Nevertheless, the high factor loadings as well as the similarities with the original factor solution (Cox & Evans, 2008) lend support for the applicability of FTNS in our developing country context. In other words, while the FTNS has a fixed structure of 13 items, the results of all case-studies show that items are sometimes combined in a different way.

It is important to mention that, besides the context, also the measurement of FTNS differed among the studies. In particular, the difference between a 5-point and 7-point Likert FTNS. In any case, the study confirms the strengths of the FTNS in assessing food technology neophobia, when the latter is considered as a multi-dimensional rather than a one-dimensional concept, as shown by CFA. This also underpins our strategy to present results of FTNS studies in two ways: a standardized, overall FTNS score and an appropriate factor solution, through CFA (confirming previous solutions) or EFA (exploring alternative solutions).

When looking at socio-demographic differences in FTNS factor scores, education could play a role to remove concerns about the risks of novel food technologies. Older people perceive new technologies in food as unnecessary, calling for initiatives to demonstrate the needs for, and benefits of such technologies. Respondents from large households, with a large income, attach more

importance to the health related aspects of the FTNS. When linking the FTNS with preferences of ones' processed *matooke* flour consumption, our results also indicate that income levels, risk and uncertainty factors, and the healthfulness were major determinants. Income, for example, appears to play an equally important role in determining the acceptance and consumption of processed *matooke*. In other words, efforts to reduce neophobia will most likely not be sufficient to increase acceptance of processed *matooke*, given its higher price. The importance of negative risk and (health) benefit perceptions in the FTNS is not surprising, as they have been considered as key barriers for acceptance of novel food technologies, such as GM foods (Bett, Ouma, & Groote, 2010; De Steur, Buysse, Feng, & Gellynck, 2013; De Steur et al., 2010; Frewer et al., 2013; Knight, Holdsworth, & Mather, 2008) and GM banana in Uganda in particular (Kikulwe et al., 2011). Besides these risk barriers, there may be other underlying factors for food technology neophobia amongst Ugandan consumers, such as usage (e.g. reluctance to shift towards processed *matooke* consumption), value (e.g. the perception that the benefits of consuming or preparing *matooke* do not justify its higher price), image (e.g. negative perceptions towards processing industries) and traditional barriers (e.g. consuming processed *matooke* requires a shift away from traditional bananas) (for an overview of key barriers for marketing innovations, see Ram and Sheth (1989)). Because this is the first FTNS study in a developing country setting, it is especially important to take into environmental and cultural factors that are specific to Uganda when comparing the findings with previous studies. For example, while income is the key determinant of consumers' evaluation of new technologies in most studies (e.g. in Canada (Chen et al., 2013)), in Uganda, market distance and marital status also play an important role. Given that markets in developing countries like Uganda are scattered and often only operate on a weekly or monthly basis, the negative influence of market distance on consumer preference for processed *matooke* can be explained by the fact that it is currently only being sold in supermarkets, most of which are far away from the majority of *matooke* consumers (i.e. usage barrier). As such, market distance is an important indicator of inaccessibility of processed *matooke* to potential consumers. The presence of a negative effect of marital status, which is only reported in our developing country context, may be linked to the preference of married respondents (as well as traditional larger families, though not significant) for traditional food patterns (i.e. traditional barrier), which are often perceived as healthier (i.e. value barrier) (Dimitri & Dettmann, 2012; Roos, Lahelma, Virtanen, Prättälä, & Pietinen, 1998). These and other context-specific variables may account for the heterogeneity in factors that determine the acceptability of food produced by innovative technologies, as confirmed in our comparison of FTNS-based studies.

Although our findings demonstrate that the success of the processing technology in *matooke* flour in the Ugandan market is affected by the relatively high degree of technology neophobia, several key limitations are worth mentioning. While this consumer study focused mainly on *matooke* consumers in and around the central business district of Kampala, future research could focus on comparing both rural and urban regions in a developing context. Although processed *matooke* flour is widely available in Kampala and other urban areas, the availability and access may be hampered in remote, rural areas, by which FTNS and its important may be differently perceived. A similar study could also be done in Uganda through expanding the study areas to cover other regions and improve the representativeness of the sample. When conducting research in developing regions, one should also consider potential biases from using/translating a (FTNS-based) questionnaire in different (local) languages. Although we opted to address this by only including people who understand English, we recognize that there could have been potential bias in our sample due to this criterion. Furthermore, as our results build upon a case-study in a developing setting, one should be careful when aiming to generalize the findings or benchmark them with other case-studies.

Our study illustrates for the first time that the FTNS can be successfully applied to a traditional food sector in a context that has received limited attention in terms of consumer behavior research. By assessing and understanding psychometric and socio-demographic effects on food preferences, the results also provide information to food producers and policy makers, to identify potential early adopters of new food products and consequently target appropriate communication strategies. The detailed knowledge about the consumer heterogeneity towards these and other food technology innovations could further help to ensure sufficient market coverage and minimize market failures. Nevertheless, further validation (e.g. tests-retest) is needed to confirm the applicability of FTNS as a survey tool in developing contexts.

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