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Consumption Pattern of Dried Traditional African Vegetables among Rural Households in Tanzania

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Abstract

Vegetables are known to be nutritious and form part of almost every meal in an African set up. However, they are known to be perishable and seasonal thus scarce during dry period. Drying helps extend their shelf life. The main objective of the study was to determine consumption pattern of dried traditional vegetables (TAVs) in semi-arid rural households. Dried TAVs by open sun drying and solar drying were considered. Cross-section data collected in 2016 among 244 respondents in Dodoma and Singida region through random sampling using semi-structured questionnaire was utilized. Ordered bivariate probit was estimated using STATA software. The results showed that access to information on drying, gender, presence of adults above 64 years, adults between 15 - 64 years, children between 5 - 14 and 0 - 4 years was significant. The information is useful in planning trainings and in determining the consumer segment to target. Strategies that would enhance information access are highly recommended.

Keywords

1. Introduction

Malnutrition is a major problem in developing countries (Holmer et al., 2013). Vegetable consumption plays a vital role in curbing malnutrition. World Health Organisation (WHO) recommends consumption of at least five portions of fruits and vegetables per day. Awareness of WHO recommendation influenced consumption of fruits and vegetables among college students (Alsunni & Badar, 2015). It is also important in reducing the risk of chronic diseases among older

people (Hazavehei & Afshari, 2016; Li et al., 2012). Fruit and vegetable consumption has an association with emotional behavior. Its consumption is positively associated with happiness (Lesani et al., 2016). Studies have shown an inverse relationship between vegetable consumption and depression. In other words its consumption is likely to lower the levels of depression (Liu et al., 2016). Older people with low vegetable intake showed high level of depression (Payne et al., 2012).

Offering vegetables to children below four years before meals increases their consumption. Introduction of vegetables to children at a tender age is important in developing their consumption habits (Elsbernd et al., 2016). Children's early consumption of fruits and vegetables significantly determines mid-childhood consumption (Kong et al., 2016; Nicklaus & Remy, 2013). Awareness creation is important in enhancing purchase and consumption of solar dried vegetables (retained high nutrients and of high quality) (Kessy et al., 2018). Individual perception, socio-economic and environmental factors are key determinants in purchase, preparation and consumption of vegetables (Kessy et al., 2018; Graham et al., 2013). Ease of cooking and training on nutritional value of vegetable enhance their consumption among school going children (Jarpe-Ratner et al., 2016). Income is also directly associated with vegetable consumption (Middaugh et al., 2012).

Despite the critical role played by vegetables they suffer from seasonality and perishability. Drying thus offers an alternative solution. For ease of preservation, transport or storage drying is important. Pretreatment before drying helps reduce nutrient loss (Oliveira et al., 2016). This study therefore focused on consumption of dried vegetables dried by open sun drying and solar drying. Open sun-dried leaves tend to dry non-uniformly and lose nutrients (namely vitamin A and C) through exposure to direct sunlight, decreasing end product quality (Musa & Ogbadoyi, 2012). Solar dried on the other hand is of high quality (high nutrient retention) and dry uniformly (Ahmed et al., 2013). The current study focused on consumption of both open sun dried and solar dried TAVs as they both contribute significantly to food nutrition security. The modeling contributes to the body of knowledge in the study of vegetable consumption.

2. Methodology

2.1. Study Area

This study was based on rural households in Tanzania officially referred to as United Republic of Tanzania (URT). Tanzania is located between 1° and 12° south of the equator and between 29° and 41° east of Greenwich meridian (Nyomora & Mwasha, 2006). This study focused on three districts of Mpwapwa and Kongwa (Dodoma region) and Iramba district (Singida region). The two districts in Dodoma were purposively selected because the World Vegetable Center had initially conducted trainings on vegetables drying. In addition, Iramba District was selected as control because it was not reached before by the

same intervention. The three districts forms part of the semi-arid central zone of Tanzania, which experiences low rainfall in short seasons which are often erratic, with fairly widespread drought in one year out of four. Total rainfall ranges from 500 mm to 800 mm per annum (URT, 2016). Moreover, temperature differences are observed between day and night and may be very high, with hot afternoons going up to 35˚C and chilly nights going down to 10˚C.

2.2. Sampling Procedure

A multistage sampling procedure was used to obtain rural consumers to participate in the survey. In the first stage, purposive sampling technique was adopted to identify the districts based on interactions with vegetables stakeholders. Divisions were purposively selected, that is, one in each district. Two wards in each division were also purposively selected and finally the villages were randomly selected. The villages are the lowest administrative unit in the country and were therefore suitable as primary sampling unit. Two villages were randomly selected from each ward.

Within each selected village, twenty households were randomly selected to give a total of 240 consumers. The selected households were visited between July and August 2016 by six trained enumerators. The respondents were either household head or the spouse of the head because they are mainly involved in food purchase decision making and preparation. From the sampling design 240 respondents were to be interviewed, that is, 80 in each of the three districts. However, 81, 81 and 82 respondents were interviewed in Mpwapwa, Kongwa and Iramba respectively giving a total of 244 respondents. Data was collected through personal interviews using pre-tested questionnaires by six trained enumerators. The data collected includes socio-economic information, information on awareness and demand for dried vegetables; product attributes on Likert scale, consumers' attitudes, perceptions and consumption.

2.3. Econometric Modeling

This was modeled by bivariate ordered probit model. The model offers an estimate between correlations of errors (Dumortier et al., 2017). Understanding consumption frequency was important in deciding the best course of action.

Consumption of solar dried TAVs and open sun dried TAVs were expressed as a frequency of consumption. The frequency of consumption was the dependent variable measured as an ordinal variable. In this study, we had five categories 1) more than twice a day, 2) once a day, 3) 1 - 2 times a week, 4) 3 - 5 times a week, 5) once a month. The consumption of the two types of dried vegetables can be estimated simultaneously by a bivariate ordered probit. Consumption frequencies of solar dried TAVs and open sun dried TAVs might not be independent thus make bivariate ordered probit suitable.

The bivariate ordered probit is a development of univariate ordered probit model. Univariate model can be expressed as:

$$y_i^\bullet = \beta X_i + \varepsilon_i \qquad (1)$$

where $y_i^\bullet$ is unobserved latent utility of consumption of dried vegetables;

β is a vector of coefficients to be estimated;

X_i is a vector of explanatory variables;

ε_i is the error term.

In this study the consumption frequencies are observed discrete categories denoted as ε_i;

$$y_i = \begin{cases} 1 & y_i^\bullet \le u_1 \\ 2 & u_1 < y_i^\bullet \le u_2 \\ \vdots & \\ l & y_i^\bullet > u_l \end{cases} \qquad (2)$$

where:

u_i is unknown cut-off of the latent utility to be estimated;

l is the number of frequency categories. For this case $l = 5$.

If the error term follows a standard normal distribution then we have;

$$
\begin{aligned}
p(y_i = 1) &= \int_{-\infty}^{-\beta x_i} \phi(\varepsilon_i)\,\mathrm{d}\varepsilon_i = \varphi(-\beta x_i) \\
p(y_i = 2) &= \int_{-\beta x_i}^{u_1 - \beta x_i} \phi(\varepsilon_i)\,\mathrm{d}\varepsilon_i = \varphi(u_1 - \beta x_i) - \varphi(-\beta x_i) \\
p(y_i = 3) &= \int_{u_2 - \beta x_i}^{u_3 - \beta x_i} \phi(\varepsilon_i)\,\mathrm{d}\varepsilon_i = \varphi(u_2 - \beta x_i) - \varphi(u_1 - \beta x_i) \\
p(y_i = 4) &= \int_{u_3 - \beta x_i}^{u_4 - \beta x_i} \phi(\varepsilon_i)\,\mathrm{d}\varepsilon_i = \varphi(u_3 - \beta x_i) - \varphi(u_2 - \beta x_i) \\
p(y_i = 5) &= \int_{u_4 - \beta x_i}^{\infty} \phi(\varepsilon_i)\,\mathrm{d}\varepsilon_i = 1 - \varphi(u_4 - \beta x_i)
\end{aligned} \qquad (3)
$$

where:

ϕ is the standard normal probability density;

φ is the cumulative distribution function;

β are unknown parameters to estimate;

ε_i is the error term.

For open sun dried TAVs and solar dried TAVs the probabilities can be given as;

$$
\begin{aligned}
&P(y_{1i} = h, y_{2i} = j) \\
&= \int_{u_{2(j-1)} - \beta_2 x_{2i}}^{u_{2j} - \beta_2 x_{2i}} \int_{u_{1(h-1)} - \beta_1 x_{1i}}^{u_{1h} - \beta_1 x_{1i}} \phi_2(\varepsilon_{1i}, \varepsilon_{2i}, \sigma)\,\mathrm{d}\varepsilon_{1i}\,\mathrm{d}\varepsilon_{2i} \\
&= \varphi_2(u_{1h} - \beta_1 x_{1i}, u_{2j} - \beta_2 x_{2i}, \sigma) - \varphi_2(u_{1(h-1)} - \beta_1 x_{1i}, u_{2j} - \beta_2 x_{2i}, \sigma) \\
&\quad - \varphi_2(u_{1h} - \beta_1 x_{1i}, u_{2(j-1)} - \beta_2 x_{2i}, \sigma) + \varphi_2(u_{1(h-1)} - \beta_1 x_{1i}, u_{2(j-1)} - \beta_2 x_{2i}, \sigma)
\end{aligned} \qquad (4)
$$

where y_{1i} is the observed frequency of consumption of open sun dried vegetable ($h = 1, \cdots, 5$) and y_{2i} is the observed frequency of consumption of solar dried vegetable ($j = 1, \cdots, 5$);

ϕ_2 is the standard bivariate normal probability density;

φ_2 is the cumulative distribution function;

σ is an unknown correlation between ε_{1i} and ε_{2i} to be estimated.

Maximum likelihood will be used to estimate β, σ, u_h, u_j, ε_{1i} and ε_{2i} in this model

Marginal effects will be calculated to estimate how change in independent variable by one unit affects the change in consumption of solar dried TAVs and open sun dried TAVs (Table 1).

The empirical model was specified as below:

$$\begin{aligned} y_{1i}, y_{2i} = {} & \beta_0 + \beta_1 \text{EducYrs} + \beta_2 \text{Age} + \beta_3 \text{Infor} + \beta_4 \text{Adult1} + \beta_5 \text{Adult2} \\ & + \beta_6 \text{Child1} + \beta_7 \text{Child2} + \beta_8 \text{Drought} + \beta_9 \text{INCOME} + \beta_{10} \text{HHpos} \\ & + \beta_{11} \text{Land1} + \beta_{12} \text{Gender} + \beta_{13} \text{Land2} + \beta_{14} \text{Kongwa} + \beta_{15} \text{Mpwapwa} \end{aligned} \quad (5)$$

3. Results and Discussions

3.1. Summary Statistics for the Demand for Dried Traditional African Vegetables

The summary statistics for demand for dried traditional African vegetables are

Table 1. Variables used to analyze consumption pattern of dried TAVs.

Code	Variable	Measurement of variable	Expected sign
Dependent variable			
y_{1i}	Frequency of consumption of sun dried vegetables	1 = more than twice a day, 2 = once a day 3 = 1 - 2 times a week, 4 = 3 - 5 times a week, 5 = once a month	
y_{2i}	Frequency of consumption of solar dried TAVs	1 = more than twice a day, 2 = once a day 3 = 1 - 2 times a week, 4 = 3 - 5 times a week 5 = once a month	
Independent variables			
Mpwapwa	Location	Dummy (1 = yes, 0 = otherwise)	+/−
Kongwa	Location	Dummy (1 = yes, 0 = otherwise)	+
Infor	Access to solar dried information	Dummy (1 = yes, 0 = otherwise)	+
Land1	Cultivate own land	Continuous	−
Land2	Cultivate leased land	Continuous	−
Age	Age of respondent	Continuous	+/−
Gender	Gender of respondent	Dummy (1 = male, 0 = otherwise)	−
HHpos	Position of respondent in the household	Head (1 = yes, 0 = otherwise)	+/−
EducYrs	Education level of respondent	Continuous	+
CHILD1	Children below 4 years	Continuous	+
CHILD2	Children between 5 - 14 years	Continuous	+
Adult1	Adults between 15 - 64 years	Continuous	+/−
Adult2	Adults above 64 years	Continuous	+/−
INCOME	Gross income	Continuous	+

as presented in Table 2. The results indicated that all the respondents were aware of open sun dried TAVs. Drying of vegetables through open sun drying is a common practice as evidenced by consumption length with a respondent having consumed it for 84 years. Since it is a common practice, awareness of open sun dried TAVs was expected to be high. The results indicated that 63.5% of respondents were not aware of availability of solar dried vegetable while only 36.5% were aware. Solar drying technology is a new practice thus this explains why 63.5% were not aware. Malik et al. (2013) point out that creating consumer awareness plays a critical role in stimulating buyers' interests in a product. Out of a total of 89 respondents who were aware of solar dried TAVs, 64.0% had consumed while 36% have not. Awareness creates demand and since solar dried TAVs are of high quality this explains why a high percentage of those who were aware had consumed it. Consumers also respond differently to technology. However, other factors like attitudes and perceptions influence consumption. Kessy et al. (2018) established that attitudes and perceptions played a significant part in consumption of solar dried TAVs.

Consumers had various reasons for consuming dried vegetables as shown in Table 3. Climate change explains why about 18.03% of the respondents consumed dried vegetables. The study area receives erratic rainfall, also considered semi-arid thus production of green vegetables throughout the year is not possible for low income rural households. Vegetable was part of almost every meal, this means high demand. Dried vegetables can be stored for long thus this explains their consumption during dry period or its consumption based on climate change. The intertwining of dried vegetables being a traditional food and climate change was the major reason for respondents consuming it (25.82% of the respondents). This implies consumers are aware of climatic changes and have put in place measures by drying vegetables to ensure their availability even during

Table 2. Consumer awareness of dried and consumption of solar dried TAVs.

Variable	Description	Frequency	Percentage
Aware of open sun dried	Yes	244	100
Aware of solar dried	No	155	63.52
	Yes	89	36.48
Aware and consumed solar dried	No	32	36
	Yes	57	64

Table 3. Reason for consuming dried vegetables.

Consumption reason	Percentage
Traditional food	7.79
Traditional food and climate change	25.82
Climate change	18.03
Climate change and no alternative	5.74

dry seasons. Consumers also have preference for dried vegetables since only 5% stated that a combination climate change and lack of alternative was the reason for consuming dried vegetables.

3.2. Summary of Consumption Pattern

From Table 4, a total of 242 respondents consumed open sun dried TAVs while two did not consume during the survey period representing 99.2% of the sampled respondents. A majority, 39.3% and 37.6% consumed it at least 1 - 2 times a day and at least 3-5 times a week respectively. This was due to the availability of open sun dried TAVs in the area of study. The results also indicated that very few respondents rarely consume it with 3.7% of the respondents consuming it at least once a month. This can be attributed to consumer awareness. On the other hand, solar dried TAVs is a new product thus 57 respondents had consumed representing 23.4% of all the respondents and 64.0% of those who were aware of its availability. A total of 33.3% have consumed it at least once a month. This signifies a high percentage of those who rarely consume it. However, 1.8% consumed it more than twice a day. The low consumption frequency can be attributed to low awareness and availability. This is consistent with the findings of Appleton et al. (2010) and Lynch et al. (2012) who argued that low awareness and availability were among major barriers to increasing vegetables and fruits consumption. A study by Mamiro et al. (2011) pointed out the need to create awareness in order to enhance the consumption of cowpea leaves among rural households.

3.3. Estimation by Ordered Bivariate Probit

The bivariate ordered probit was used to analyze consumption pattern and frequency for both solar and open sun dried TAVs. The model was suitable because it allowed for joint modelling of the two consumption frequencies and thus offered simultaneous results. Consumption frequencies of sun dried and solar dried TAVs are dependent variables. Pre-diagnostic tests were done before carrying out econometric analysis. Multicollinearity is a serious problem in any econometric analysis, therefore, variance inflation factor test was done on continuous variables and pairwise correlation on categorical variables. However,

Table 4. Consumption frequency of sun and solar dried TAVs.

Consumption frequency of open sun dried TAVs (n = 242)			Consumption frequency of solar dried TAVs (n = 57)		
Frequency	Freq.	Percentage	Frequency	Freq.	Percentage
once a month	9	3.7	once a month	19	33.3
3 - 5 times a week	91	37.6	3 - 5 times a week	14	24.6
1 - 2 times a day	95	39.3	1 - 2 times a day	19	33.3
once a day	21	8.7	once a day	4	7.0
more than twice a day	26	10.7	more than twice a day	1	1.8

from the results it showed that multicollinearity was not a problem. The results of pre diagnostic tests are as presented in Table 5.

3.4. Consumption Pattern Estimated Ordered Bivariate Probit

Table 6, represents the estimated coefficients for the model. Estimated coefficients and standard errors are reported for consumption of each of the traditional African dried vegetables. From the results there is an overall goodness fit with appropriate chi-square. The model strongly fits and is statistically significant prob. > chi^2 = 0.000 and a log likelihood of −112.313.

For open sun dried TAVs gender of the respondent was significant at 10% significance level. Males were less likely to consume open sun dried TAVs. Females were more likely to consume open sun dried TAVs. Females are mainly involved in food preparation including drying and cooking. This can also be attributed to the role women play in food purchase and food preparation. The results concur with the findings of Ngigi (2010) who argued that women were major purchasers of vegetables. Presence of adults above 64 years was also significant at 10%. This is an age bracket of old people. Old people consider open sun dried TAVs as their traditional food; it is what they have grown up consuming. They tend to be conservative in nature and reluctant to new products. They would therefore, prefer to frequently consume open sun dried TAVs as opposed to solar dried TAVS. Old people tend to stay at home thus have limited information on solar dried TAVs. However, some who are aware cannot afford as they have a lot of financial needs to meet.

Market quality attributes were significant at 1%. Market quality attributes, that is, price, drying method, colour, freshness, nutritional value, packaging and hygiene were more likely to influence consumption frequency of open sun dried TAVs. This can be attributed to affordability and storability. Consumers develop

Table 5. Variance inflation factor test results for multicollinearity.

Variable	VIF	1/VIF
Age of the respondent	2.8	0.3571
Years consuming dried TAVs	2.27	0.4398
Number of adults above 64 years of age	1.52	0.6577
Number of adults between 15 - 64 years of age	1.21	0.8291
Years of schooling	1.2	0.8322
Income in us dollars	1.2	0.8364
Cultivate own land	1.17	0.8553
Cultivate leased land	1.1	0.9054
Presence of children below 4 years	1.1	0.9091
Presence of children between 4 - 14 years	1.05	0.9520
Mean VIF	1.42	

Note: VIF = variance inflation factor.

Table 6. Consumption frequencies of sun and solar dried TAVs estimated by means of a bivariate ordered probit model.

Variable	Open sun dried TAVs		Solar dried dried TAVs	
	Coefficient	Std. Error	Coefficient	Std. Error
Socio-economic characteristics				
Age of household head (years)	−0.020	0.019	0.030	0.020
Gender	−0.923*	0.560	1.239*	0.741
Education in years	−0.025	0.080	0.498	0.386
Household size				
Children below 4 years	0.068	0.250	0.016*	0.092
Children between 5 - 14 years	−0.029	0.140	0.543**	0.288
Adults between 15 - 64 years	0.161	0.134	−0.320**	0.161
Adults above 64 years	0.748*	0.429	−0.339	0.150
Household income in us dollars	0.002	0.001	0.034	0.468
Cultivate own land Hactors	0.011	0.054	−0.050	0.057
Cultivate rented land in Hactors	−0.116	0.231	0.130	0.249
Attitudes and perceptions				
(market quality attributes)	0.799***	0.232	0.885***	0.267
(product intrinsic qualities)	−0.015	0.197	−0.290	0.214
Climatic characteristics				
Prolonged drought	0.194	0.341	−0.256	0.372
Institutional characteristics				
Mpwapwa	0.550	0.475	0.710	0.507
Kongwa	0.178	0.418	0.224	0.431
access to information			−7.310***	1.990
No of observations	55			
Log likelihood	−112.313			
Wald ch^2	314.99			
Prob. > ch^2	0.000			

Note: ***: significant at 1% level; ** significant at 5% level; * significant at 10%. Iramba is the base. TAVs—traditional African vegetables.

trust on a product if regularly consumed. Considering open sun drying being old practice consumers have developed trust on it. Solar dried TAVs are relatively expensive compared to open sun dried. Consumers tend to make choices based on price thus the low cost of open sun dried TAVs can be driving factor. Boisseau (2019) identified high cost as a barrier to increasing consumption of vegetables among consumers with poor socio-economic background. These results confirm the findings of Davidson et al. (2012) who indicated that market quality attributes such as price, product freshness and nutritional value influenced consumers' purchasing decisions.

For solar dried TAVs gender was significant at 10%. Unlike for open sun dried males were more likely to frequently consume solar dried TAVs. In rural setting males have high purchasing power as they have resources like land ownership at their disposal. Males considering their roles in vegetable purchase and preparation have little knowledge on their quality thus would use price as an indicator of quality. Solar dried considering its high quality is a bit expensive compared to open sun dried TAVs. Presence of children of ages below 4 was significant at 10%. This is an actively growing group therefore got high food demands. Solar dried TAVs also retained the green colour attractive to children. Presence of children between 5 and 14 years was also significant at 5%. Households with children aged between 5 and 14 were more likely to consume solar dried TAVs more frequently. Solar dried TAVs are nutritious therefore a preference for this segment. The results are consistent with the findings of Albani et al. (2017) who points out the need for consuming vegetables among children aged between 5 and 14 years. Number of adults between 15 and 64 years was significant at 5% significance level. Adults between 15 and 64 are less likely to consume it. They are likely to consume a variety of foods apart from vegetables thus reduction in their consumption frequency. This age category is active and productive. This implies they are able to produce the fresh vegetables. The results are consistent with findings of Senyolo et al. (2014) who argued that individual who produced fresh vegetables were less likely to purchase vegetables from the market.

Access to information on solar dried TAVs was very significant at 1%. Majority of the respondents (80%) had not accessed information on solar dried TAVs. Lack of information explains negative relationship on consumption frequency of solar dried TAVs and information access. This contradicts with the findings of Depositario et al. (2009) who argued that awareness of availability does not necessarily lead to increased consumption for a product.

4. Conclusion

Though open sun dried is of low quality as compared to solar dried TAVs, consumption of both types is important in combating food nutrition insecurity. Gender, product marketable characteristics and access to information are important in consumption of dried traditional African vegetables and highly influence the consumption frequency. Enhancing access to information and segmentation based on gender is important in increasing consumption of solar dried African vegetables which is of high quality. This study makes a significant contribution to the body of knowledge in understanding determinants of consumption of traditional African vegetables. However, a sample size of 244 is too small to make for generalization of the whole population. A bigger sample size is recommended for further studies. This was a cross-sectional study carried out towards the end of 2016. A longitudinal study is recommended to understand trends in consumption over time.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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