*Original Research Article*

# Determinants of utilisation of tomato value addition technology among beneficiaries in Oyo State, Nigeria

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## Abstract

Value addition is essential in the tomato value chain, especially in the wake of an increasing rate of tomato postharvest loss. Both governmental and non-governmental organisations have trained small-scale entrepreneurs on Tomato Value Addition Technology (TVAT). A dearth of information on the utilisation of TVAT necessitated this study. A two-stage sampling procedure was used to select 142 respondents. Data were elicited from respondents with the aid of a questionnaire and analysed using frequency counts, percentages, multiple linear regression, and multivariate probit model at $\alpha_{0.05}$. The results revealed that most (54.9%) of the respondents had a high level of knowledge on TVAT and a favourable attitude (60.6%) towards TVAT. However, the level of utilisation of TVAT was low (69.7%). Lack of funds (68.3%), NAFDAC registration requirements (66.9%), and high cost of processing equipment (57.0%) were prominent constraints militating against utilisation of TVAT. Constraints to the utilisation of TVAT ($\beta$ = –0.395), age ($\beta$ = –0.022), and income ($\beta$ = 0.095) determined the utilisation of TVAT. Membership in a cooperative society ($\beta$ = 0.221), income ($\beta$ = 0.375) and constraints ($\beta$ = –0.213) predicted the utilisation of tomato paste. Educational qualification ($\beta$ = 0.132), cooperative society ($\beta$ = 0.059), income ($\beta$ = 0.336), and knowledge of TVAT ($\beta$ = 0.229) predicted the utilisation of ketchup. Age ($\beta$ = –0.112), income ($\beta$ = 0.026), years of experience ($\beta$ = 0.031), knowledge of TVAT ($\beta$ = 0.311), and constraints ($\beta$ = –0.093) predicted the utilisation of puree, whereas factors associated with the utilisation of dry slice tomato technology, were age ($\beta$ = 0.107), marital status ($\beta$ = 0.050), household size ($\beta$ = 0.042) and years of experience ($\beta$ = 0.219). Adequate funding is a *sine qua non* to the sustainability of agricultural technologies. The study recommended the need for more training on the utilisation of the technology, encouragement to form cooperative groups to facilitate easy access to funds, and establishment of cottage industry among stakeholders.

**Keywords**: *Lycopersicon esculentum;* AgroImpact tomato training; small-scale entrepreneurs; tomato processing; ketchup; tomato paste; dry slice; technologies

## INTRODUCTION

Value addition in agriculture has attracted more attention from both national and international agencies in recent years because of its tremendous potential for improving the shelf life of agricultural produce and increasing farmers' income. A shift from production-oriented technology to a broader objective that emphasises production, value addition, and marketing in all value chain stages in order to reduce post-harvest losses and boost stakeholders income has emerged (Agwu et al., 2015; Kennedy, 2015; Tobin et al., 2016; Salvioni et al., 2020), In Nigeria, fruits and vegetable production constitute a large part of agricultural production, contributing to food and income security of stakeholders in the value chain. Tomatoes, pepper, and onions are the major vegetables and are important ingredients consumed almost by all Nigerians.

Tomato (*Lycopersicon esculentum*) is among the major vegetables widely grown and consumed in all parts of the World (Arah et al., 2015; Ugonna et al., 2015; Global Alliance for Improved Nutrition, 2021), it easily fits into different cropping systems and could grow a year-round planting cycle where conditions are favourable. Globally, tomato accounts for about 60% of total vegetable production with an estimated production of 177 million tonnes in 2016. Asia accounts for about 60% of global tomato production between 2006 and 2016, with China producing about 31.87% of the world tomato production, followed by India with 10.39% (FAOSTAT 2018). Nigeria is a major player in the production of tomatoes in the world with 3.69 million tons produced in the year 2020, occupying 13$^{th}$ and 2$^{nd}$ positions in the world and Africa, respectively (Udoh, 2020). However, about 50 percent (900,000MT) of tomatoes produced in Nigeria are lost every year due to several factors some of which are poor harvesting practices, poor postharvest handling, lack of storage facilities, lack of access roads, and poor mode of transportation, low capacity of local cottage processing industries among others (Ugonna et al., 2015, Ibrahim et al., 2020). Corollary to this assertion, Murtala (2020) posited that the annual post-harvest loss of tomatoes in Nigeria accounted for more than 40% of total production. This accounted for yearly scarcity and a hike in the price of fresh tomato fruits, particularly between late April to Mid-August. As a result, Nigeria still spends up to $50 million every year to import tomato products, especially purees, pastes, and canned tomatoes, making the country one of the biggest importers of tomato paste in the world (FMARD 2014; TOPAN, 2019). Meanwhile, the development of low-cost technologies for processing tomatoes into products that can prolong their shelf life can help to reduce/eliminate some of the losses and importation of their products.

Therefore, the need to envisage possible affordable value-addition technologies that can be used to process raw tomatoes into a more durable form becomes imperative. This will not only extend the shelf life but can open new markets, promote farms and lengthen market seasons (Hussaini et al., 2021) thereby increasing the income of stakeholders in the tomato value chain and exportation of tomato products. Various research has been carried out on the best value addition technology to adopt or utilise in order to extend the shelf life and preservation of the freshness and quality of the product from the time of harvest to final consumption. Technologies such as 'Controlled Atmosphere Storage', passive and active 'Modified Atmosphere Packaging', cold storage, waxing, and chlorine treatment, have been employed, all in the bid to extend the postharvest shelf life and quality (Aremu et al., 2017). In Nigeria, value addition has come to the forefront of agricultural policy to strengthen small farms and farmers survive due to the fact that agriculture activity is in the hands of rural poor farmers operating at the subsistence level. On tomatoes, the Nigerian government has been making efforts to promote domestic growth in processed tomatoes. One such move was the Transformation Agenda which identified the need to exploit and utilise available agricultural resources and enhance the development and dissemination of appropriate and efficient technologies for rapid adoption in value addition through the processing chain.

Similarly, in an attempt to reduce post-harvest losses of tomatoes, preserving it at the time of surplus for all-year-round supply as well as ensure better income for small-scale tomato entrepreneurs, capacity building on tomato processing and preservation using easy and affordable technologies were organised in Ibadan metropolis by both Governmental and Non-Governmental organisations, namely: Agro-Impact Project and Empowerment Initiative, National Organic Association of Nigeria (NOAN), National Horticultural Research Institute (NIHORT) and Nigerian Stored Product Research Institute (NSPRI)). The training covered important aspects of the commodity value chains such as the economics of production, value addition, and marketing of tomatoes in order to reduce wastage and make tomatoes available for consumption all year round.

The affordable tomato value addition technology focused on by these organisations include tomato paste, puree, ketchup, and tomato powder which according to Emodi and Osilem (2018), Archana and Jitendra (2018) are important ingredients in the preparation of several delicacies such as salads, sauces, *jollof rice*, and stews. Nigerians' heavy reliance on tomato vegetable soups and stews is the fact that their staples are mostly starch and vegetable-based. Thus, large quantities of tomatoes are consumed in combination with other crops such as bell pepper, scotch bonnet, hot pepper, onions blended with the skin, and seeds for the smooth paste. In the tomato value addition training, the blended mixture of tomato, onions, scotch bonnet, and hot pepper is boiled to thick, filled in a glass jar or bottle while hot, pasteurised, then stored at room temperature. The technology is free of additives, and easy to use. It helps to preserve the product for about six months, reduces post-harvest loss of the crop, makes the product available in a form easy for utilisation by various individuals, requires less processing and time, saves end-users time, serves as income-generating activity, and controls fresh tomato price fluctuations among others (Tripathi et al., 2017).

In spite of the accessibility, affordability, and simple nature of the tomato paste technology, however, the product is yet to be seen in the retail markets which implies that the majority of the participants have not put the training acquired into practice; if the training has been utilised at all, there are no empirical studies to establish the extent to which the technology has been utilised and the factors associated with its utilisation among the participants in the training exercise. Meanwhile, the decisions of beneficiaries of the training to utilise or not utilise the technology are assumed to be determined by many factors. Several studies have shown that level of education, membership in an association, availability of processing and storage facility, participants' interest, information sources, owner's characteristics, and organisations' innovativeness determined the adoption of tomato processing technologies (Akangbe et al., 2014; Obafunmi et al., 2014; Mesike and Okwu-Abolo, 2022). In addition, gender, access to credit, age, group membership, and income were documented as the main factors that determine tomato farmers' willingness to adopt innovative timing approaches for the management of climate change effects in Taita Taveta county of Kenya while the price and non-price factors determined production and supply of tomatoes in Cameroon (Moranga et al., 2016; Tabe-Ojong et al., 2020). Could these established factors be determinants of utilisation of tomato value addition technology among training beneficiaries in Ibadan metropolis? There is a need to establish what actually determines tomato value addition technology utilisation among participants. It is against this backdrop that this study sought to ascertain the level of utilisation of tomato value addition technology as well as the factors associated with its utilisation among the training beneficiaries. The specific objectives were to determine the knowledge of training beneficiaries on TVAT, determine the attitude of trainees on the tomato value addition technologies, identify the perceived constraints to the utilisation of the technology and establish factors associated with the utilisation of the technology. The study hypothesised that utilisation of TVAT is influenced by respondents' socioeconomic characteristics, knowledge, attitude, benefits, membership in cooperatives, and constraints among others.

## Conceptual framework

The idea of Reasoned Action served as the foundation for the presumptions that people's attitudes might affect how they use TVAT. It has been discovered that attitudes and subjective norms are significant predictors of people's intentions to carry out an activity, such as embracing and utilising new technology (Dissanayake et al., 2022). According to Fishbein and Ajzen (1975), a person's behaviour is influenced by both his/her intention and attitude toward an action. An individual's attitude toward the behaviour, in turn, determines whether they intend to engage in the behaviour in question. The intention is among the various determinants of prospective behavioural outcomes. As a person's willingness to carry out the desired behaviour, intention is represented cognitively and is seen as an early predictor of behaviour. The relative strength of a person's propensity to carry out a planned behaviour is measured by behavioural intention. On the other hand, the subjective norm is defined as a combination of perceived expectations from relevant parties and the intention to meet those expectations.

An individual behavioural intention is formed by his or her attitude in conjunction with their perception. As a result, behavioural intention can predict actual conduct because it depends on both attitudes toward activity and subjective norms for that behaviour. For instance, altering one's attitude frequently could trigger a change in behaviour since it is thought that attitude affects behavioural intentions, which are deliberate choices to carry out particular activities like using TVAT.

The dependent variable of the study which is utilisation of tomatoes technology is measured through the dimensions of tomato value addition methods: dry slice powder, ketchup, tomato paste, and tomato puree. The independent variables are socio-economic factors, knowledge, and attitude towards the TVAT and constraints to utilising tomato value addition technology.

In comparison to small-scale tomato processors who have a high level of knowledge, a positive attitude, and few constraints, it was anticipated that tomato processors who demonstrated a low level of knowledge, a negative attitude, and faced with many challenges in relation to use of TVAT would exhibit a low utilisation of tomato value-addition technologies. It was further hypothesised that social and economic factors like sex, age, educational attainment, and membership in organisations would affect the use of TVAT among small-scale tomato processors. Figure 1 provides a graphic illustration of the conceptual model that underlies this study.

## MATERIALS AND METHODS

The study was conducted in Ibadan metropolis, the capital of Oyo State. The metropolis is composed of eleven Local Government Areas (LGAs), six on the outskirts and five at the center. The latter are Ibadan South East, Ibadan North East, Ibadan North West, Ibadan Southwest, and Ibadan North Local Government Areas. Ibadan is located between longitude 7°20′ and 7°40′ East of the Greenwich meridian and between latitude 3°55′ and 4°10′ North of the equator. Predominantly, food crops such as yam, maize, cowpea, cassava, okra, tomato, amaranths, and melon which reflect the dietary habits of the inhabitants are grown. The population of the study comprised small-scale entrepreneurs. A two-stage sampling procedure was used for the selection of respondents for the study. Firstly, a purposive sampling technique was used to select all participants in the training on tomato value addition technology conducted by NIHORT (85), AgroImpactProject Empowerment Initiative (67), NOAN (35) and NSPRI (50). The second stage involved a random selection of 60% of participants from all the above-mentioned organisations to give a total of 142 respondents. Data for the study were collected from respondents using a structured questionnaire that was administered as an interview schedule. Knowledge of respondents on tomato value addition (10) was measured by administering a knowledge test which elicited responses that were scored as correct = 1 and incorrect = 0. The mean (5.0) of the correct scores was obtained and used to categorise respondents' knowledge of tomato value addition technology to high (mean and above) and low (below mean). Attitude to tomato value addition technology (8) was measured using a five-point Likert-type scale of strongly agree, agree, undecided, disagree, and strongly disagree with

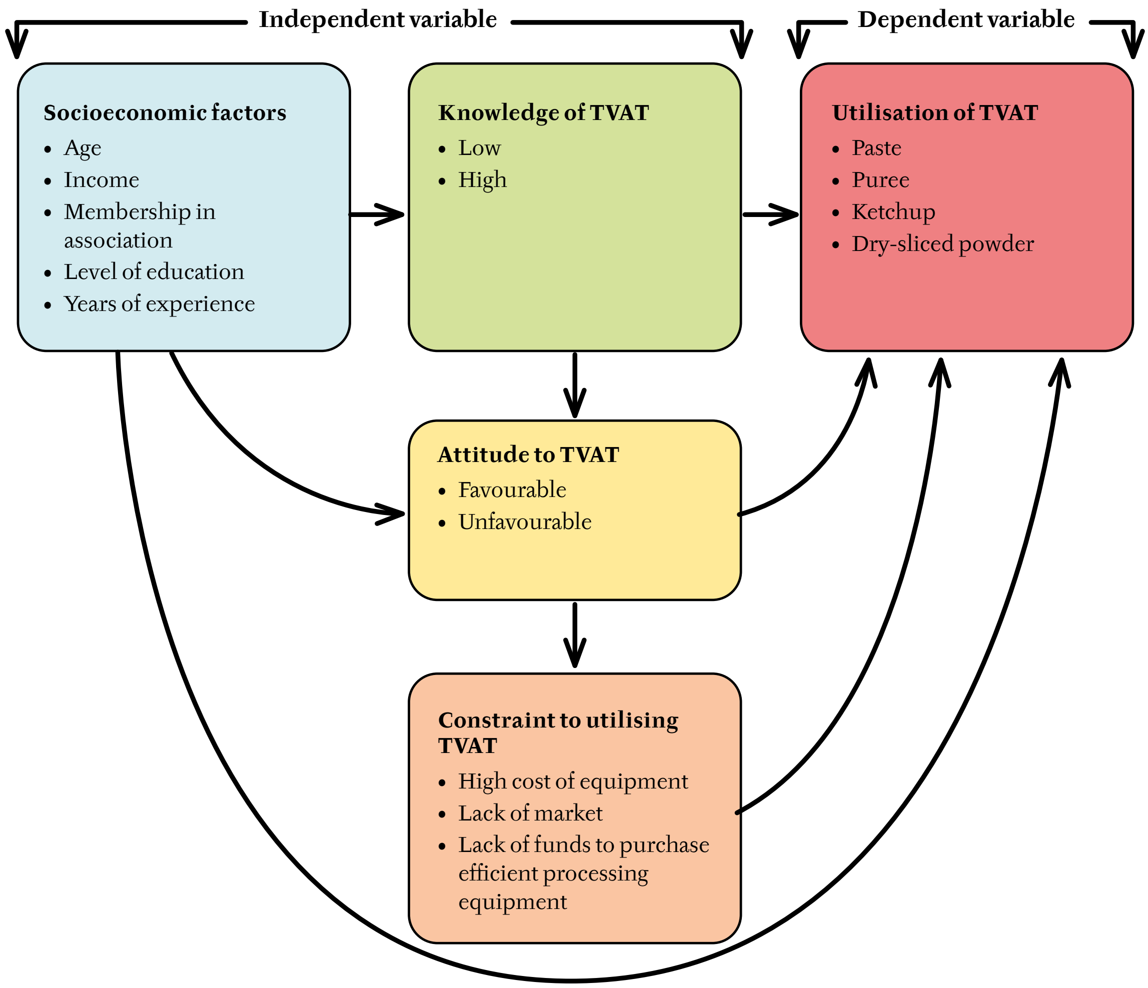


**Figure 1.** Conceptual model on determinants of utilisation of tomato value addition technologies

the score of 5, 4, 3, 2, and 1, respectively, for positive statements and reverse order of the scores for negative statement. The mean (24.9) was obtained and used to categorise respondents' attitudes to favourable (mean and above) and unfavourable (below mean). Constraints to utilisation of tomato value addition technology were measured as severe = 2, mild = 1, not a constraint = 0. The mean score of each item was generated and used to rank them in order of severity. Utilisation of tomato value addition technology was measured as always = 2, occasionally = 1 and never = 0. The mean was obtained and used to categorise respondents' utilisation of tomato value addition technology into high (mean and above) and low (below mean). Multiple Linear regression model for contribution of selected independent variables to respondent's utilisation of tomato value addition technology is expressed as:

$$Y = a + b_1X_1 \ldots\ldots\ldots\ldots\ldots\ldots + bn\, X_n + e$$

where:

Y = Respondent's utilisation of value addition technology (composite score)

a = Constant term

$b_1, b_2 \ldots b_n$ = Regression coefficient

e = error

$X_1, X_2 \ldots$ Xn = regression parameters which include

$X_1$ = Age (actual age in years)

$X_2$ = Household Size (actual number in persons)

$X_4$ = Educational level

$X_5$ = Income (amount in naira)

$X_6$ = Participation in social group (yes = 1, no = 0)

$X_7$ = Year of experience (actual years of experience)

$X_8$ = Knowledge of tomato value addition technologies (composite score)

$X_9$ = Attitude towards tomato value addition technologies (composite score)

$X_{10}$ = Benefits derived from tomato value addition technologies (composite scores)

$X_{11}$ = Constraint to utilisation of tomato value addition technology

A multivariate probit (MVP) model was further used to determine the factors that influenced the utilisation of tomato value addition technologies (paste, puree, ketchup, and dry-sliced powder). Accordingly, the observed outcome of the utilisation of tomato technologies can be modeled following random utility formulation. Consider $i^{th}$ processor ($I = 1, 2, 3, \ldots\ldots N$) which is facing a decision on whether or not to utilise paste (PA), puree (PU), ketchup (KE), and dry-sliced powder (DS).

Tomato processor decides to use the $K^{th}$ technology if $Y^*ipk = U^*k - U > 0$. $Y^*$ ipk derive from $K^{th}$ (tomato technology) is a latent variable determined by observed characteristics ($X_{ip}$) and unobserved characteristics ($U_{ip}$):

$$Y^*_{ipk} = X'_{ipk}j + U_{ipk}, \text{ where } (k = PA, PU, KE, DS) \quad (1)$$

Using the indicator function, the unobserved preferences in Eq. (1) translate into the observed binary outcome equation for each choice as follows:

$$Yk = \{1 \text{ if } Y^* ipk > 0\ (k = PA, PU, KE, DS);\ 0 \text{ (otherwise)} \quad (2)$$

Where the type of Tomato value addition technology is indicated by the numbers k = 1, 2 in Eq. (1), it is assumed that a rational processor in the kth choice of TVAT has a latent variable Yipk that captures the unobserved properties or demand. The utilisation of kth TVAT is considered to be affected by factors such as the observed features X'ipk, unseen characteristics reflected by the stochastic error term Uipk, and observed characteristics X'ipk. The j stands for the vector of parameters that need to be estimated. Given the latent nature of Y*ipk, the estimations are based on observable binary discrete variables Yipk, which indicate whether or not a tomato processor undertook a particular TVAT. If the use of one technology is independent of whether or not a technology is utilised

**Table 1.** Variables inputted to the model

| Variables | Type of variable | Description of variables |
|---|---|---|
| **Age** | Continuous | Actual age in years |
| **Marital status** | Dummy | Married (1), 0 (otherwise) |
| **Household size** | Continuous | Number of people in a household |
| **Educational qualification** | Dummy | Formal (1), otherwise (0) |
| **Cooperative /organisation membership** | Dummy | Yes (1), No (0) |
| **Income** | Continuous | Monthly income in Naira |
| **Years of experience** | Continuous | Number of years engaged in tomato processing |
| **Knowledge** | Continuous | Knowledge index |
| **Attitude** | Continuous | Attitude index |
| **Constraints** | Continuous | Constraint index |

by the processor and the error terms are normally distributed, then Eqs (1) and (2) describe multivariate probit models, in which information of a tomato processor's use of one technology does not affect the prediction of the likelihood that they would use another technology. If the utilisation of a variety of tomato value-adding technology is feasible, a more realistic definition is to presumptively assume that the error terms in Eq. (1) jointly exhibit a multivariate normal (MVN) distribution with a zero conditional mean and variance normalised to unity where Uipk MVN (0) and the covariance matrix $\varepsilon$.

## RESULTS AND DISCUSSION

### Socioeconomic characteristics

Table 2 shows that the mean age of respondents was 42.2 ± 9.4 years. This implies that the majority of the respondents belongs to a middle-aged group; known for their physical ability, productivity, and mental alertness in learning new technologies (Onoja et al., 2012). Table 2 also shows that most (67.6%) of the respondents were female, whereas only 32.4% were male. This implies that the training was dominated by women probably because it deals with value addition technologies. Digun-Aweto

**Table 2.** Distribution by respondents' socio-economic characteristics

| Variables | Frequency | Percentage | Mean |
|---|---|---|---|
| **Age (in years)** | | | |
| 18–27 | 13 | 9.2 | 42.2 ± 9.4 years |
| 28–37 | 32 | 22.5 | |
| 38–47 | 55 | 38.7 | |
| 48–57 | 38 | 26.8 | |
| 58–67 | 4 | 2.8 | |
| **Gender** | | | |
| Male | 46 | 32.4 | |
| Female | 96 | 67.6 | |
| **Educational** | | | |
| Non-formal | 7 | 4.9 | |
| Primary | 15 | 10.6 | |
| Secondary | 9 | 6.3 | |
| Tertiary | 111 | 78.2 | |
| **Household size** | | | |
| 1–3 | 27 | 19.0 | |
| 4–6 | 87 | 61.3 | 5.3 ± 2.3 |
| 7–9 | 26 | 18.3 | |
| >9 | 2 | 9.4 | |
| **Years of experience** | | | |
| <2 years | 114 | 80.3 | |
| 2–3 years | 26 | 11.3 | 2.2 ± 2.0 years |
| >3 years | 2 | 1.4 | |
| **Income in naira** | | | |
| ₦20,000–₦69,999 | 114 | 80.3 | |
| ₦70,000–₦119,999 | 22 | 15.5 | ₦63,424 ± ₦65,948.94 |
| ₦120,000–₦169,999 | 4 | 2.8 | |
| ≥₦170,000 | 2 | 1.4 | |
| **Cooperative society** | | | |
| Member | 54 | 38.0 | |
| Non-member | 88 | 62.0 | |

Source: field survey, 2021

and Oladele (2017) reported that females are mostly engaged in value-addition activities. The result is in line with Kehinde and Aboaba (2016) that cottage-level processing activities are dominated by women. Table 2 further shows that the average household size of respondents was 5.3 ± 2.3 persons. This implies that respondents with larger household sizes are more likely to be motivated toward utilisation of technologies that in turn will enhance productivity and enable them to cater to the needs of their household. The educational attainment of respondents as presented in Table 2, indicates that the majority (95.1%) of the respondents had one type of formal education or the other while only a few (4.9%) had no formal education. This implies that respondents are highly educated, and it is expected that educated individuals would be receptive to innovation and technology. This agrees with Adebayo et al. (2021) that education facilitates farmers' receptiveness to improved techniques, and utilisation of new technologies. The result in Table 2 further revealed that 80.3% of the respondents had less than two years of experience, 18.3% had between 2 and 3 years of experience, and another 1.4% had above 3 years of experience. This implies that the majority of the respondents had little or no value-addition experience due to the timing of the training. The result in Table 2 revealed that the annual income of respondents was ₦63,424 ± ₦65,948.94. This indicates that respondents were low-income earners. This is in agreement with the findings of Uzoejinwa et al. (2016) that small-scale food processors in Nigeria are dominated by low-income earners. Table 2 shows that 62.0% of the respondents did not belong to any cooperative society; only a few of the respondents (38.0%) belonged to one cooperative or another. Belonging to a cooperative society would likely enhance access to information on improved technology, capital and processing equipment and therefore enhance the utilisation of tomato value addition technology. This result corroborates the findings of Kehinde and Aboaba (2016) who found that majority of cottage-level cassava value adders are non-members of cooperative society, and this may impede progress associated with group activities such as the opportunity for group bargain and capital mobilisation.

## Respondents' knowledge of tomato value addition technologies

Table 3 shows that about eight items of the knowledge questions were correctly answered by most of the respondents. This is evident as 90.1% of the respondents knew that dried sieved tomato paste can be processed into powder form. Table 3 further shows that 89.4% of the respondents were knowledgeable that tomato ketchup undergoes eight processes, 86.6% knew that sterilisation is one of the processes in tomato ketchup/tomato puree, 85.9% were knowledgeable of the fact that pulp and juice are filtered through screens and processed further into ketchup, 78.2% knew that washing is the first process in the tomato puree processing. This indicates that respondents understood the technicalities and processes surrounding the use

**Table 3.** Distribution of respondents' knowledge of tomato value addition technology

| Knowledge statements | N=142 Response | % |
|---|---|---|
| The tomato ketchup processing undergoes eight processes | 127 | 89.4 |
| Washing is the first process in the tomato puree processing | 111 | 78.2 |
| Pulp and juice are filtered through screens and processed further into ketchup | 122 | 85.9 |
| Sterilization is one of the processesin tomato ketchup/tomato puree | 123 | 86.6 |
| While cooking, the temperature must be carefully regulated to ensure absorption of the ingredients without overcooking. | 73 | 51.4 |
| Boiling and pulping is not a necessary step in processing tomato into ketchup | 18 | 12.7 |
| Formulation of tomato until it thickens is not a necessary step in processing tomato into ketchup | 31 | 21.8 |
| Processed tomato paste filled in glass jars should be tightly sealed | 103 | 72.5 |
| Sterilization of jars can be done using hot water | 103 | 72.5 |
| Dried sieved tomato paste can be processed into powder form | 128 | 90.1 |

Source: Field survey, 2021

**Table 4. Categorisation of respondents' knowledge of tomato value addition technologies**

| Level of knowledge | F | % | Min | Max | Mean | SD |
|---|---|---|---|---|---|---|
| **Low (0.00–4.90)** | 64 | 45.1 | 0 | 10 | 5.00 | 3.60 |
| **High (5.00–10.00)** | 78 | 54.9 | | | | |

Source: Field survey, 2021

**Table 5.** Distribution of respondents based on attitude towards tomato value addition technology

| Attitudinal statements | SA | A | U | D | SD | Mean |
|---|---|---|---|---|---|---|
| I may experience challenges in accessing tomato value addition technology whenever I need it | 9.1 | 18.2 | 9.1 | 27.3 | 36.3 | 3.63 |
| The use of tomato value addition technology might facilitates the effectiveness of tomato processing | 18.2 | 50.0 | 9.1 | 13.6 | 9.1 | 3.54 |
| Processing tomato into ketchup and paste is likely requires many skills | 30.5 | 17.3 | 4.1 | 23.6 | 24.5 | 3.95 |
| Tomato value addition technology is not likely better than traditional tomato processing | 9.1 | 18.2 | 4.5 | 40.9 | 27.3 | 3.59 |
| Tomato value addition technology can only be used by literate | 4.5 | 4.5 | 9.1 | 22.8 | 59.1 | 4.27 |
| I will continue to use tomato value addition technology even if the price can sometimes be prohibitive | 4.5 | 9.1 | 13.7 | 40.9 | 31.8 | 2.14 |
| I perceive that the use of tomato value addition technology would increase my income | 81.9 | 13.6 | 4.5 | 0 | 0 | 4.77 |
| The use of tomato value addition technology would increase the quantity of output for the same amount of input | 9.1 | 9.1 | 36.4 | 27.3 | 18.2 | 3.36 |

**Grand mean = 3.66**
Source: Field Survey, 2021

**Table 6.** Categorisation of respondents' attitude towards tomato value addition technology

| Level | F | % | Min | Max | Mean | SD |
|---|---|---|---|---|---|---|
| **Unfavourable (16.00–24.90)** | 56 | 39.4 | 16.00 | 29.00 | 24.91 | 3.01 |
| **Favourable (24.91–29.00)** | 86 | 60.6 | | | | |

Source: Field survey, 2021

of the technology. This might further prompt their inclination to use the technology. This assertion is consistent with Barnes et al. (2019) that when individuals are better informed on the mechanisms of a technology, they tend to relate well with it and show a high level of inclination to its utilisation. Table 3 also shows that 72.5 % knew that sterilisation of jars can be done using hot water. The result in Table 3 reveals that more than half (54.9 %) of the respondents had a high level of knowledge. The mean knowledge of 5.0 falls within high knowledge which justifies the fact that the respondents were well-informed about tomato value addition technology. The high level of knowledge could further stimulate respondents to think more critically and creatively on tomato processing activities. Ferretti and Afonso (2017) noted that increased knowledge gives rise to new ideas as well as the possibility of developing a positive disposition toward innovation.

## Beneficiaries' attitude towards tomato value addition technology

The respondents perceived that the use of tomato value addition technology would increase their income ($\bar{x}$ = 4.77) as shown in Table 5. This confirms the fact that the respondents view tomato value addition technology as a means of increasing their income. This aligns with the findings of Fatuase et al. (2019) who reported an increase in income among cassava processors after technology adoption. Furthermore, respondents disagreed that only literate people can utilise the tomato value addition technology ($\bar{x}$ = 4.27). In the same vein, the respondents disagreed that the tomato value addition technology requires many skills ($\bar{x}$ = 3.95) and that they may experience challenges in accessing tomato value addition technology whenever they need it ($\bar{x}$ = 3.63). This indicates that the technology is user-friendly and can be easily understood by both literates and illiterates. Taoufik (2020) noted that a less complex technology could facilitate its adoption. On the other hand, most of the respondents disagreed that they will continue to use tomato value addition technology even if the price is unaffordable. This suggests that despite their positive disposition towards the compatibility and ease of use of the technology, high cost could hinder its utilisation. This is in congruence with the findings of Tijani and Sanusi (2020) who identified cost as one of the determinants of the utilisation of technology among shea butter processors. The categorisation of respondents based on attitude towards tomato value addition technology revealed that most (60.6 %) had favourable attitudes, whereas 39.4 % had unfavourable attitudes. Respondent's knowledge of the technology could be responsible for steering their disposition toward a positive direction. In line with this assertion, Azman et al. (2013) opined that adequate

**Table 7.** Constraints to utilisation of tomato value addition technology

| S/N | Items | S | M | NC | Mean | Rank |
|---|---|---|---|---|---|---|
| 1 | High cost of processing equipment | 69.7 | 10.6 | 19.7 | 1.50 | 1st |
| 2 | Lack of funds to buy efficient processing equipment | 68.3 | 11.3 | 20.4 | 1.48 | 2nd |
| 3 | NAFDAC registration | 66.9 | 12.0 | 21.1 | 1.46 | 3rd |
| 4 | Poor policy on value addition | 57.0 | 19.7 | 23.2 | 1.34 | 4th |
| 5 | Inadequate knowledge about processing steps | 18.3 | 29.6 | 52.1 | 0.66 | 5th |
| 6 | Lack of market | 12.0 | 25.4 | 62.7 | 0.49 | 6th |

Source: Field survey, 2021

knowledge of a particular technology can influence the attitudes of such individuals positively.

### Constraints to the utilisation of tomato value addition technology

The distribution of respondents based on the array of constraints faced in the utilisation of tomato value addition technologies as shown in Table 7 reveal that the high cost of processing equipment ($\bar{x}$ = 1.50) and lack of funds to buy processing equipment ($\bar{x}$ = 1.48) ranked first and second as major constraints to the utilisation of tomato value addition technology. This indicates that constraints faced by the respondents' stem from financial capability. The inability of the respondents to afford the cost of processing equipment could be because they are low-income earners. Ibrahim et al. (2020) observed that tomato processing is faced with challenges of high cost of processing and packaging machinery and equipment as well as harassment by law enforcement agencies such as National Agency for Food, Drug and Administration Control (NAFDAC) on raw materials and finished products. This agrees with the findings of Anyiro and Onyemachi (2014) who reported a lack of funds as a major constraint to the utilisation of value-added innovation among cassava processors. However, inadequate knowledge about processing steps and lack of market were the least constraints faced by respondents.

### Utilisation of value addition technology

Table 8 shows that some of the respondents blend tomato to a smooth paste ($\bar{x}$ = 0.57) and drain off excess water from boiled tomato paste ($\bar{x}$ = 0.50). Also, some of the respondents recook until thick extra juice is gotten to make ketchup ($\bar{x}$ = 0.47), in making tomato puree some of the respondents chop the tomato fruits and heat in a pot or saucepan ($\bar{x}$ = 0.43), while the process of turning tomato skin and baking for 1–2 hours until they are completely dried ($\bar{x}$ = 0.35) were utilised for dry slice powder. Considering the grand means, of each of the value addition processes, tomato paste ($\bar{x}$ = 0.46) and ketchup ($\bar{x}$ = 0.35) were prominent. However, the fact that more than 50% of the responses were indicated as "never" suggests that the technologies were not mostly utilised by the respondents. This further gives credence to the result in Table 8 on the level of utilisation of tomato value addition technology as the majority (69.7%) of the respondents had a low level of utilisation, while a few (30.3%) had a high level of utilisation. The low level of utilisation of value-added technology by the respondents could be attributed to certain constraints such as the high cost of procuring processing equipment and lack of funds to buy efficient processing equipment. This result is consistent with the findings of Ewebiyi et al. (2020) who attributed constraints as a major reason for low utilisation of technologies by cassava processors despite their favourable attitude towards the technology.

### Determinants of utilisation of tomato value addition technologies

The multiple regression analysis was performed to determine the effect of the independent variables on levels of utilisation of value addition technologies in tomato processing. The result of the regression analysis is presented in Table 10. The coefficient of determination $R^2$ = 0.361 indicates that 36.1% variation in the overall utilisation index of value addition technologies was explained by the variables included in the model. The results in Table 10 show the important factors influencing the utilisation of value addition technologies by respondents.

The coefficient for age is found to be significant ($p \leq 0.05$) and negatively related to the utilisation of value addition technologies. Controlling for other factors, the coefficient of 0.022 means that respondents' age would decrease the level of utilisation of value addition technologies by 2.2%. In other words, the higher the age of respondents, the lower the level of utilisation of value addition technologies. This result negates the findings of Kolapo et al. (2020) who indicated a high level of utilisation of improved processed technology among old locust bean processors than their young counterparts in Southwest, Nigeria.

Participation in a cooperative society has a significant ($p \leq 0.05$) positive effect on utilisation of

**Table 8.** Distribution of respondents according to their level of utilisation of value addition technologies

| Tomato value addition technology | Always | Occasionally | Never | Mean |
|---|---|---|---|---|
| **Dry slice powder** | | | | |
| I remove tomato skin and bake for 1-2 hours until they are completely dry but not burnt | 7.0 | 20.9 | 72.1 | 0.35 |
| I mill/grind my dry tomato slice | 5.9 | 0 | 94.1 | 0.12 |
| I sometimes dry sieved tomato paste into powder | 2.2 | 22.2 | 75.6 | 0.27 |
| Grand mean = 0.25 | | | | |
| **Ketchup** | | | | |
| I ensure recook until thick extra juice to get ketchup | 10.0 | 26.7 | 63.3 | 0.47 |
| I boil my tomato fruits before pulping | 6.7 | 13.3 | 80.0 | 0.27 |
| I often go for the non-cook route, which entails the addition of tomato paste and a little water instead of canned tomatoes | 3.3 | 16.7 | 80.0 | 0.23 |
| Grand mean = 0.35 | | | | |
| **Tomato paste** | | | | |
| I blend my tomato fruits to a smooth paste | 1.0 | 36.7 | 53.3 | 0.57 |
| I drain off excess water from my boiled tomato paste | 10.0 | 30.0 | 60.0 | 0.50 |
| I keep my cooked tomato paste inside a glass jar | 3.3 | 26.7 | 70.0 | 0.33 |
| Grand mean = 0.46 | | | | |
| **Tomato puree** | | | | |
| I chop the tomato fruits and heat in a pot or saucepan | 19.6 | 3.9 | 76.5 | 0.43 |
| I strain the sauce to remove any seeds or leftover skin | 7.8 | 0 | 92.2 | 0.16 |
| After removing the tomato from the heat, I allow it to cool and run the sauce quickly through a blender or food processor | 4.9 | 9.8 | 85.3 | 0.19 |
| Grand mean = 0.26 | | | | |

**Table 9.** Respondents' level of utilisation of tomato value addition technology

| Level of utilisation | Freq. | % | Min. | Max. | Mean | SD |
|---|---|---|---|---|---|---|
| **Low (1.00–5.55)** | 99 | 69.7 | 1.00 | 22.00 | 5.56 | 8.79 |
| **High (5.56–22.00)** | 43 | 30.3 | | | | |

Source: Field survey, 2021

value addition technologies. This entails that increased participation in cooperative thrift can lead to increased utilisation of tomato value addition technologies. One explanation for this result is that respondents' participation in cooperative thrifts would promote new technologies, offer professional training, ease members' access to value addition technologies and equipment, and connect market information with management practice. This is consistent with the findings of Ogbodo et al. (2021) that farmers who participate in cooperative society activities tend to adopt improved agricultural technologies.

As expected, the coefficient for income had a significant ($p \leq 0.05$) positive effect on the utilisation of tomato value addition technologies. The coefficient of 0.09 for income means that an increase in respondents' income will increase the utilisation rate of tomato value addition technology by 9 percent. This result is in tandem with the findings of Kolapo et al. (2020) who reported a positive and significant relationship between income and adoption of improved technologies among locust bean processors. Constraints to utilisation of tomato value addition technology have a negative and significant effect on the utilisation of the technology. This indicates that the higher the constraints, the lower the utilisation of tomato value addition technologies. In other words, an increase in challenges such as high cost of processing equipment, lack of funds to buy efficient processing equipment and bottle necks inherent in registering products with food control agency reduces the utilisation of TVAT. A multi-variate probit regression was further employed to determine the factors associated with the utilisation of tomato value addition technologies.

## Econometric result

With significant Wald Chi-square statistic ($Chi^2 = 553.48$, $p < 0.001$) and Chi-square statistic for the log-likelihood ratio test ($Chi^2 = 35.12$, $p < 0.001$)in Table 10, the results of the multivariate probit model for utilisation decisions show that whether or not to

**Table 10.** Determinants of utilisation of tomato value addition technologies

| | Beta | t-value | p-value |
|---|---|---|---|
| **(Constant)** | | 2.470 | 0.000 |
| Age | –0.022** | 2.558 | 0.001 |
| Marital status | 0.064 | 0.396 | 0.695 |
| Household size | 0.227 | 1.298 | 0.204 |
| Educational level | 0.225 | 1.334 | 0.192 |
| Cooperative society | 0.119* | 2.333 | 0.024 |
| Income | 0.090* | 2.744 | 0.031 |
| Years of experience | 0.199 | 1.257 | 0.218 |
| Knowledge | 0.101 | 1.642 | 0.251 |
| Attitude | 0.007 | 1.463 | 0.389 |
| Benefits | 0.050* | 2.513 | 0.030 |
| Constraint | –0.395** | 3.690 | 0.000 |
| **Diagnostic Statistics** | | | |
| F value | | 2.374 | |
| Sig. | | 0.000 | |
| R | | 0.601 | |
| R square | | 0.361 | |
| Adjusted R square | | 0.103 | |
| Std. Error of the estimate | | 6.839 | |

**($p < 0.01$); *($p < 0.05$)

**Table 11.** Estimated model test and covariance of the correlation matrix

| Correlation matrix | Rho | | Correlation matrix | Rho | |
|---|---|---|---|---|---|
| | Coefficient | Standard error | | Coefficient | Standard error |
| **PAKE** | 0.079 | 0.063 | **PUPA** | 0.008 | 0.069 |
| **PADS** | –0.017 | 0.052 | **KEPU** | 0.117** | 0.056 |
| **DSKE** | 0.133** | 0.061 | **PUDS** | 0.087 | 0.060 |

KE = Ketchup; PA = paste; DS = Dry-spice powder; PU = Puree
Estimated covariance of the correlation matrix
rhmoKEPU = rhmoPADS = rhmoKEDS = rhmoPUPA = rhmoPAKE = rhmoPUDS = 0
$chi^2 = 35.1188$; prob > $chi^2$; Number of draws = 3; Number of Observations = 142; Wald $chi^2 = 553.48$; prob > $chi^2 = 0.000$

use one tomato value addition technology (TVAT) are dependent on the utilisation decision of the other technologies. The result, thus, supports the use of a multivariate probit model. The use of paste and ketchup are positively and significantly related. This might be explained by how ketchup and tomato paste both have a thick consistency. Similar positive and strong relationships exist between paste and puree. This could be because tomato puree functions well as a substitute for tomato paste. Although, purée is quite thinner than paste, but cooking it over medium heat for few minutes before adding recipes can produce a good result. However, the pairwise coefficient between puree and ketchup is negative and significant, suggesting that the paired tomato value addition technologies can be substituted for one another.

### Factors influencing utilisation of tomato value addition technologies

A positive and significant relationship exists between membership in cooperative society and utilisation of tomato paste technology (Table 12). This entails that increased participation in cooperative thrift can lead to increased utilisation of tomato paste technology. One explanation for this result is that respondents' participation in cooperative thrifts would promote new technologies, offer professional training, ease members' access to tomato technologies and equipment, and connect market information with management practice. This is consistent with the findings of Ogbodo et al. (2021) that farmers who participate in cooperative society activities tend to adopt improved agricultural technologies. Likewise, income positively and significantly affects the utilisation of tomato paste technology. This indicates that an increase in income among small scale tomato processors increases the likelihood of utilising tomato paste technology. This result is in tandem with the findings of Kolapo et al. (2020) who reported a positive and significant relationship between income and adoption of improved technologies among locust bean processors. However, an inverse relationship was found between constraints faced by tomato processors and utilisation of tomato paste. This suggests that an increase in challenges such as high cost of processing equipment and lack of funds results in reduction of utilisation of tomato paste technology by small-scale tomato processors.

On the utilisation of ketchup technology, the educational qualification of processors affects the utilisation positively. This is because higher education influences individual decision, hence educated small scale tomato processors would be receptive, rational and able to analyse the benefits of ketchup. This is in consonance with the study of Okunlola et al. (2011) that education increases farmers' ability to process and use information relevant to adoption of new technology. Participation in cooperative society also affects the utilisation of ketchup positively and significantly. This is in agreement with the study of Mmbando and Baiyegunhi (2017) that membership of groups/associations significantly influence adoption of agricultural technology. Similarly, knowledge on use affects ketchup positively and significantly and influenced its utilisation. This suggests that small scale tomato processors with higher levels of knowledge of tomato value addition technology would utilise more of ketchup. This finding is consistent with Walter et al. (2017) who reported that knowledge of a technology is a critical determinant of innovation behavior.

Determinants of utilisation of puree technology revealed a negative but significant coefficient of respondents' age with utilisation of puree technology. This indicates that young small-scale tomato processors are more likely to utilise tomato puree than their older counterparts. This confirms the risk aversion component in the diffusion theory; older farmers are more risk averse, and are less likely to experiment with new technology. This agrees with the work of Suleman (2012) who reported a negative and significant association between age and utilisation of agricultural technology. Respondents' income significantly affects the utilisation of puree. This suggests that an increase in income increases the probability of utilising puree tomato value addition technology. This aligns with the study of Fadeyi et al. (2022) that income positively predicts the adoption of agricultural technology. Similarly, the result showed that the probability of years of processing experience increases with increase in the utilisation of puree. This is consistent with the study of Ateka et al. (2021) who reported a positive and significant association between years of experience and utilisation of technology among tomato producers in Kenya. The result further showed that knowledge of tomato value addition technology has positive and significant influence on utilisation of puree. This implies that high level of knowledge of tomato value addition increases the utilisation of puree. This is because good knowledge of the technology would facilitate better understanding of the workability and economic value of the technology by tomato processors. This result is in consonance with Hörner et al. (2022) that knowledge facilitates the adoption of agricultural technology. Constraints to the utilisation of tomato technology have a significant and negative influence on utilisation of puree technology. This aligns with the result of Udimal et al. (2017) who reported an inverse relationship between constraints and adoption of agricultural technology.

For the determinants of utilisation of dry slice technology age of small-scale tomato processors has positive and significant influence on utilisation. This indicates that the likelihood of utilising dry slice tomato powder is higher among older small-scale tomato processors than their young counterparts. Young processors may find sun drying as a difficult task compared to older processors who may have gathered experience and as such may not necessarily see the activities in dry-slice tomato powder as a burden. This supports the finding of Kariyasa and Dewi (2013) that older individuals tend to gain knowledge and experience over time and are better able to evaluate technology information than young individuals. In the same vein, marital status has a positive and significance influence on utilisation of dry-slice tomato powder. This indicates that married tomato processors were more likely to utilise dry-slice tomato powder than the unmarried. This is in line with the work of Olatade et al. (2016) that marital status tends to influence adoption of agricultural innovation. Likewise, household size has positive and significant influence on the utilisation of dry-slice tomato powder. Household size is often considered a proxy for labour availability. Since dry-slice tomato powder requires some level of sun drying, a large household size could make use of household members in carrying out processing activities. This negates the findings of Eze et al. (2022) who reported a negative and significant relationship between household size and adoption of value addition technology among cashew processors in South-East Nigeria. Years of experience in processing also

**Table 12.** Multivariate Probit model

| Variables | Paste | Ketchup | Puree | Dry-slice powder |
|---|---|---|---|---|
| **Age** | 0.113<br>(0.081) | 0.020<br>(0.073) | –0.112*<br>(0.027) | 0.107*<br>(0.021) |
| **Marital status** | 0.034<br>(0.083) | 0.046<br>(0.103) | 0.003<br>(0.008) | 0.050**<br>(0.016) |
| **Household size** | 0.049<br>(0.037) | 0.200<br>(0.115) | –0.058<br>(0.137) | 0.042**<br>(0.031) |
| **Educational qualification** | 0.075<br>(0.093) | 0.132**<br>(0.024) | 0.045<br>(0.109) | 0.183<br>(0.125) |
| **Cooperative society** | 0.221**<br>(0.101) | 0.059**<br>(0.020) | 0.168<br>(0.119) | 0.042<br>(0.025) |
| **Income** | 0.375*<br>(0.153) | 0.336*<br>(0.015) | 0.026**<br>(0.010) | 0.034<br>(0.016) |
| **Years of experience** | 0.034<br>(0.109) | –0.182<br>(0.074) | 0.031*<br>(0.085) | 0.219*<br>(0.087) |
| **Knowledge** | 0.041<br>(0.127) | 0.229**<br>(0.012) | 0.311*<br>(0.117) | 0.301<br>(0.014) |
| **Attitude** | 0.012<br>(0.035) | 0.030<br>(0.105) | 0.050<br>(0.105) | 0.009<br>(0.108) |
| **Constraints** | –0.213*<br>(0.031) | –0.047<br>(0.413) | –0.093**<br>(0.035) | –0.013<br>(0.020) |

Numbers in parentheses are standard error
**($p < 0.01$); *($p < 0.05$)

impacted positively and significantly on the utilisation of dry-sliced powder. This implies that the likelihood of utilising dry-sliced powder technology is high with an increase year of experience.

## CONCLUSION AND RECOMMENDATIONS

Despite respondents' high level of knowledge of tomato value addition technologies and favourable attitude towards the technology, its utilisation was low due to the high cost of processing equipment and lack of funds to buy processing equipment. Respondents' age, income, participation in cooperative thrift, benefits derived from tomato value addition technology and constraints to use influenced the utilisation of tomato value addition technology in the study area. Hence, the following recommendations were made based on the findings of this study:

1. Relevant stakeholders, agencies and government should make available credit facilities for small-scale tomato processors to enable them utilise the technology.
2. Extension agents should encourage small-scale tomato processors to participate in cooperative thrifts to enable them to pool resources together and facilitate the acquisition of tomato value addition technology equipment.
3. Extension agents should educate agricultural cooperative societies on means of actively seeking collaborations with external technology providers, academic and research institutes as well as commercial innovation companies.

## CONFLICT OF INTEREST

The authors declared no conflicts of interest with respect to the research, authorship, and publication of this article.

## ETHICAL COMPLIANCE

The authors have followed ethical standards in conducting the research and preparing the manuscript.

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