

STUDIES ON SORTING AND GRADING PRACTICES OF TOMATOES (*Solanum Lycopersicum*) IN KANO CLUSTERED AREAS NIGERIA

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ABSTRACT

*Tomato (*Solanum Lycopersicum*) fruit is an important crop with a high nutritional value. It contains proteins, carbohydrates, fiber and vitamins. Tomatoes and other fruits and vegetables are important parts of human diets. The quest of consumers to have quality foods made sorting and grading of food materials unavoidable. Sorting could reduce handling losses of tomatoes during transportation and it adds value to the products. Despite the importance of sorting and grading of tomatoes to its processing, storage, transportation and marketing there is little or no information on how the processors of tomatoes in tomato production cluster areas of Kano State go about this important task. The present study therefore, seeks to carry out studies on tomato sorting and grading in the study area. The study was carried out using a structured questionnaire to collect data from the tomato processors to shed light on the areas where researchers and engineers needed to play roles to alleviate the drudgeries involved in the sorting and grading of this important product. Data collected from the questionnaires were analyzed using simple percentages of responses obtained and charts were used to illustrate the results. The results show that 88% of the tomato processors are young and energetic people whose occupations need to be enhanced. Few respondents (15%) have experience of 10 years and above, probably because of the tediousness of the work many people tend to stop the work as they are ageing. A total of 87% of the respondents agreed that sorting and grading are very important and they greatly affect the sales of tomatoes. Variety, colour, size and spoilage of tomatoes are the factors that are mostly considered by buyers of tomatoes. UC-82B variety of tomato has the highest mean values in most of the physical properties measured, having a width, weight, arithmetic mean diameter, geometric mean diameter, aspect ratio, sphericity and surface area of 53.63 mm, 0.25 kg, 52.27 mm, 51.00 mm, 96.35, 0.92 and 9637 mm² respectively. These are important parameters needed for the design of tomato sorting machines. It is therefore recommended that the findings from this study should be taken into consideration in the design and fabrication of sorting machines for our local tomato varieties.*

Keywords: Tomato, sorting, grading, practices, Kano clustered physical properties.

1 INTRODUCTION

Regular consumption of fresh fruits, vegetables or their respective juices can be a vital part of a balanced human diet and can play a significant role in the prevention of several diseases. Tomatoes are rich in vitamins A, B1, B2, B6, C and E and minerals such as potassium, magnesium, manganese, zinc, copper, sodium, iron and calcium. Tomatoes have a high nutritional value because they include proteins, carbohydrates, fiber, folic acid, tartaric acid, succinic acid and salicylic acid [1]. With the importance of tomatoes and other fruits and vegetables in human diets and the quest of consumers to have quality foods, sorting and grading of the fruits and vegetables became imperative. Handling practices of tomato like harvesting, precooling, cleaning and disinfecting, sorting and grading, packaging, storing, and transportation played an important role in maintaining quality and extending shelf life [2]. The removal of rotten, damaged, or diseased fruits from the healthy and clean ones is important because damaged or diseased fruits can produce ethylene in

substantial amounts which can affect the adjacent fruits [3]. Sorting based on colour or maturity stage helps to eliminate overripe fruits which will easily produce ethylene to hasten the ripening process in the whole lots. Tomato fruits are generally sorted on basis of size, shape colour and firmness to different grades. Graded fruits are more welcome in the export market. Sorting could reduce handling losses during transportation. The need to be responsive to market demand places a greater emphasis on quality assessment, resulting in the greater need for improved and more accurate grading and sorting practices [4]. The grading and sorting of fruits is a prerequisite and vital step in the processing of fruits. This could be accomplished by various methods and principles. The operation has to be completed very accurately causing minimum damage to the fruits. Grading is the process of categorizing materials according to their quality only. While sorting is the process of categorizing materials based on different properties of the material, quality inclusive. Hence, grading is a subset or a type of sorting. Sorting means separating the products by variety, size, colour, quality etc, so that the set of fruit resulting presents uniformity [5]. The sorting of fruits and vegetables is one of the most important process in fruit production, and this process is typically performed manually in most countries [6]. [2] noted that, commercial producers of tomatoes normally use sophisticated systems that require precise sorting and grading standards for their produce. While, small-scale producers and retailers in developing countries in contrast may not use written down, grading and sorting standards; however, the product must still be sorted and sized to some degree before selling or processing it. Mechanical sorting and grading of fruits and vegetables are not that common in Nigeria except probably in few large processing firms. Manual sorting and grading are more popular and it is usually carried out by operators who considered several grading factors and fruit are separated according to their physical quality. Tomato graders in developing countries as labourers who use only eyes inspection and experience in sorting out the good tomatoes from the lot and their experience of many years in the tomato work give a grader professionalism in the job [7]. Even with experience, human operations may be inconsistent, boredom, less efficient and time-consuming. The physical and mechanical properties of tomato fruits are very pertinent and crucial in the design of mechanised equipment for harvesting, cleaning, sorting, grading, storing and packaging for transportation from farms to processing plants or market places [8]. Despite the importance of sorting and grading of tomato to its processing, storage, transportation and marketing there is little or no information on how the farmers in the study area go about this important task. The present study therefore, seeks to: 1) Carry out studies on the tomato sorting and grading practices at Kwanar Gafan in Garun Mallam LGA and Liberia Market in Dambatta- Makoda LGAs tomato production cluster in Kano State. 2) Determine some physical properties of local varieties of tomatoes pertinent to sorting and grading of tomatoes. This is expected to shed light on the areas where researchers and engineers needed to play roles to alleviate the drudgeries involved in the process of this important product.

2 MATERIALS AND METHODS

2.1 Tomato Sorting and Grading Practices in the Study Areas

The study on the tomato sorting and grading practices in the study areas was carried out using a structured questionnaire. Figure 1 presents the map of Kano State showing the various local government areas. The shaded portions are the tomato production clusters in Kano state, Nigeria. For the present study, Kwanar Gafan in Garun Mallam LGA and Liberia Market in Dambatta- Makoda LGA of Kano state were selected because they are the tomato production clusters areas where experience tomato processors who carryout sorting and grading are concentrated. The study was carried out using a structured questionnaire to collect data from the tomato processors. The focus of the questionnaire includes years spent in sorting tomatoes, sorting techniques used, factors considered when sorting, quality factors desired by buyers, cost of sorting, time of sorting and difficulty/fatigue associated with the sorting. In each of the markets, twenty-five (25) processors were randomly selected. A total of fifty (50) questionnaires were used. Data collected were analyzed using simple percentages of responses obtained and charts were used to illustrate the results.

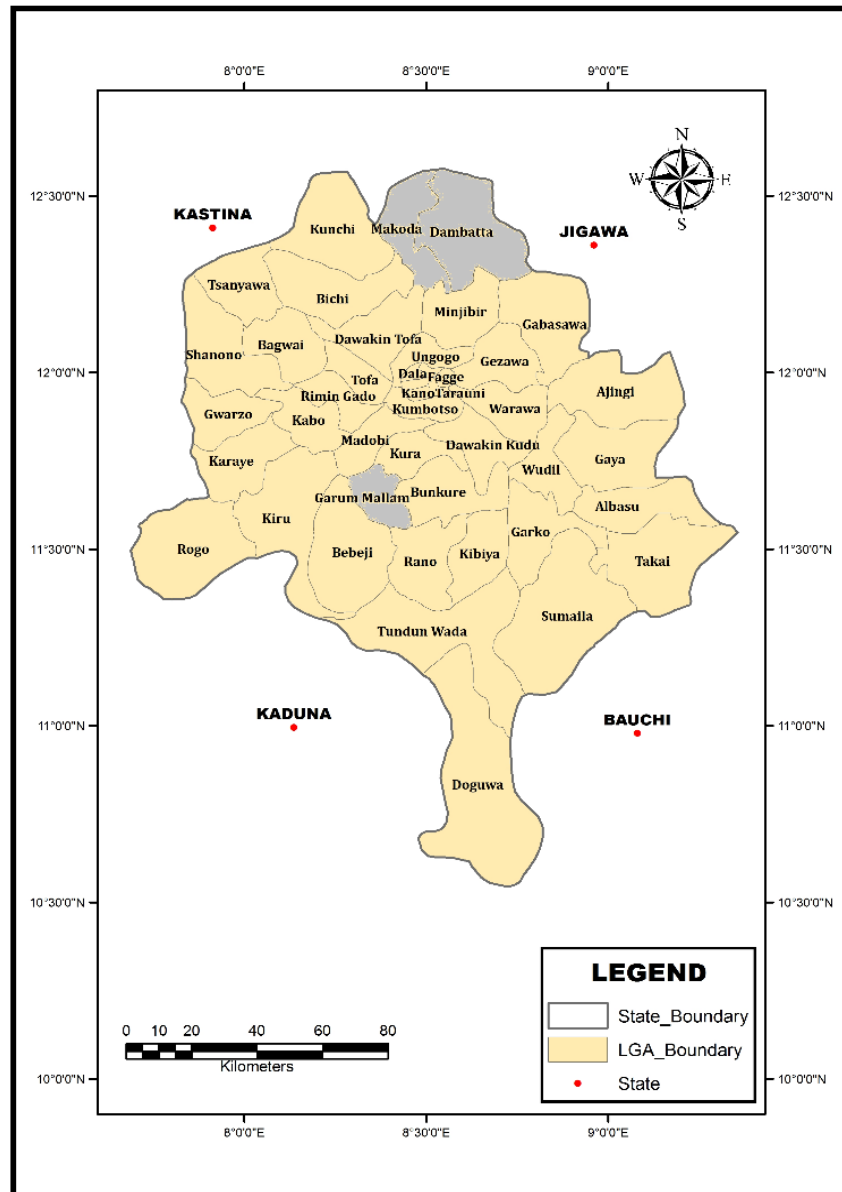


Figure 1. Map of Kano showing Local Government Areas [9]

2.2 Physical Properties of Local Varieties of Tomatoes

The physical properties of local varieties of tomatoes that are pertinent to the sorting and grading of the products were determined using the methods described by [8, 10, 11].

2.2.1 Sample preparation

30 kg each of three varieties of tomatoes Roman VF, UC-82B and Divar which is readily available varieties of tomatoes was purchased from Centre for Dryland Agriculture “CDA’s Fresh from the Farm” a fruits and vegetable outlet on the New site campus of Bayero University Kano (BUK), Nigeria. 50 samples were randomly selected from the lots. The samples were washed and drained. Experiments for the physical properties were done in the Processing Laboratory of Agricultural and Environmental Engineering BUK. The three linear dimensions, the length (L), the width (W), and the thickness (T) were measured directly by the use of Vernier Calipers (Mitutoyo 530-119). The following physical properties (arithmetic mean diameter (D_a), geometric mean diameter (D_g) aspect ratio (R_a) sphericity (S) and surface area (S_f) were calculated from the linear dimensions of the fruits using Equations 1-5 respectively [8, 10, 11].

$$D_a = \frac{L + W + T}{3} \tag{1}$$

$$D_g = (L \times W \times T)^3 \tag{2}$$

$$R_a = \frac{W}{L} \tag{3}$$

$$S = \frac{D_g}{L} \tag{4}$$

$$S_f = \pi(D_g)^2 \tag{5}$$

3 RESULTS AND DISCUSSION

Table 1 presents the frequencies and percentages of respondents to various questions asked during the study.

Table 1. Frequencies and percentages of respondents to various questions

S/N	Questions	Frequencies	Percentages	
1.	Age of respondents	Below 20 years	14	29
		20-40 years	29	59
		Above 40 years	13	13
2.	Years of experience in sorting tomatoes	1-4 years	24	47
		5-9 years	19	38
		10 years and above	7	15
3.	Importance of sorting and grading of tomatoes	Very important	44	87
		Important	5	10
		Not very important	1	3
4.	Methods of sorting	Manual	50	100
		Machine	0	0
5.	Parts of body ache	Waist	40	80
		Back	38	76
		Eyes	10	20
		Hands	25	50
6.	Factors considered in sorting	Variety	4	8
		Colour	22	44
		Size	14	28
		Spoilage	10	20
		Others (specify)	0	0
7.	Varieties of Tomato grown	Roman VF	32	64
		UC 82-B	13	26
		Others	5	10

3.1 Age of respondents

Age is very important in agricultural production because it determines the physical strength of the farmer. Also, the young people tend to withstand stress and put more time in various farming operations, this will likely increase output. Figure 2 presents by percentage the age distribution of the respondents in the study area.

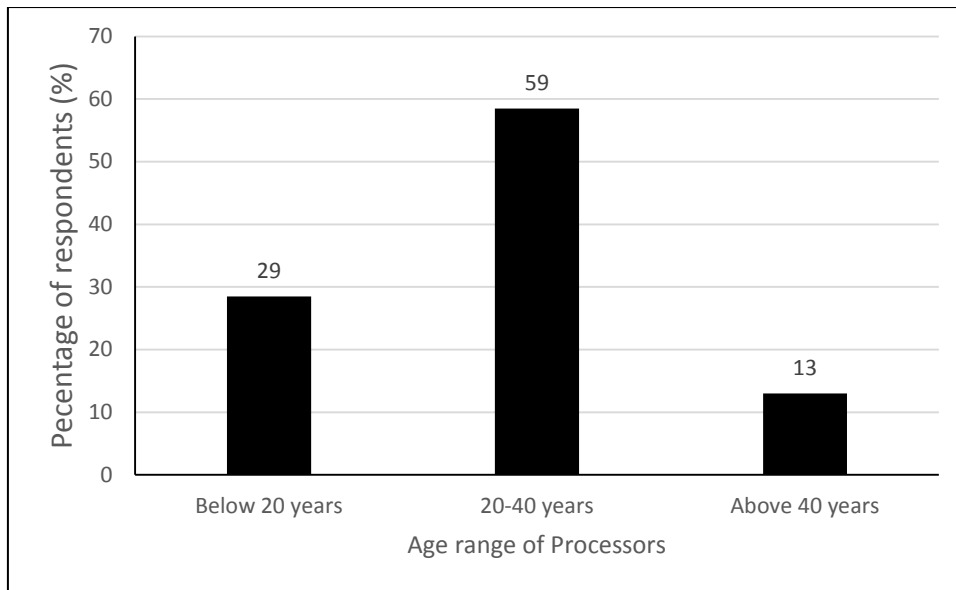


Figure 2. Age distribution of the respondents

From the 50 respondents interviewed, the results show that 29% of the respondents are below 20 years old, 59% are in the age range of 20-40 years and 13% are above 40 years of age. It can therefore be deduced that the majority (about 88%) of the tomato processors are young and energetic people.

3.2 Years spent sorting tomatoes

Figure 3 maps the percentage of respondents to the years of experience in tomato sorting in the study areas.

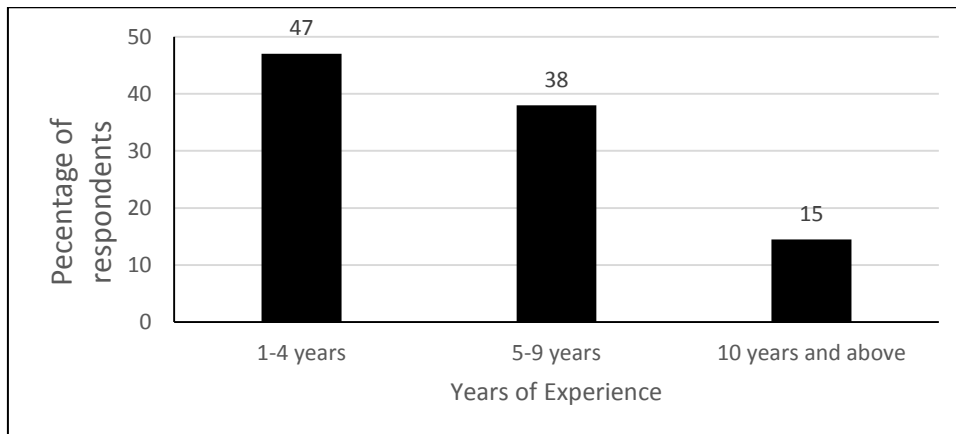


Figure 3. Years spent sorting of tomatoes

The results obtained showed that the processors with plenty of years of experience are fewer. Processors with experience of 1-4years are 47%, processors with experience of 5-9years constitute 38% and processors with experience of 10years and above are 15%. The results show that few respondents have experience of 10 years and above in the study areas. This is probably because of the tediousness of the work many people tend to stop the work as they are ageing. It shows that the work is for vibrant young people who can withstand the stress involved. Therefore, attempts to develop an automatic sorting machine will be highly supported.

3.3 Effect of sorting and grading on the sales of tomatoes

Figure 4 shows the opinions of the tomatoes processors on the effect of sorting and grading on the sales of tomatoes.

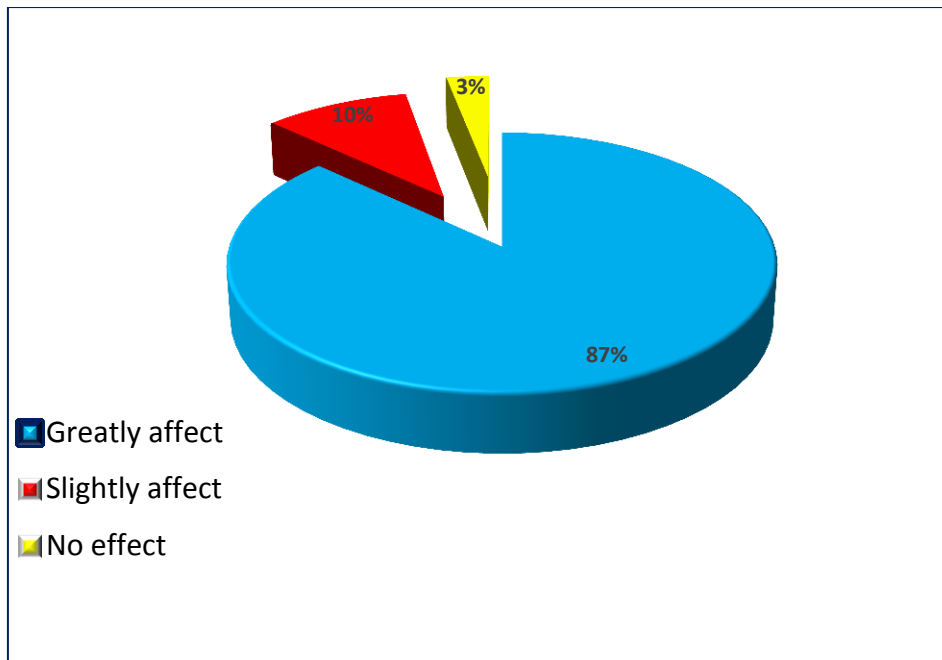


Figure 4. Effect of sorting and grading on the sale of tomatoes

In Figure 4, the outcome from the 50 respondents show that 87% of the respondents agreed that sorting and grading are very important and they greatly affect the sales of tomatoes, while 10% of the respondents opined that sorting and grading slightly affect the sales of tomatoes and 3% says sorting and grading does not affect the sales of tomatoes. It is therefore evident that majority of the respondents understood the importance of the operation. The majority of the respondents realized that sorting and grading of tomatoes add value to the products and gives the customers confidence in buying the products.

3.4 Method of sorting and fatigue

All the respondents in the study area use the manual method of tomatoes sorting and no single machine sorting mechanism is found in the areas. The respondents unanimously agreed that there is fatigue during the sorting operation. This is because the operation required fully both the physical and the mental attention of the sorter.

3.5 The parts of the body that hurts most when sorting

Body pain is a major difficulty faced during the manual sorting and grading of fruits and vegetables that require the attention of researchers. Figure 5 presents the charts showing the different parts of the body that hurts during the sorting and grading of tomatoes.

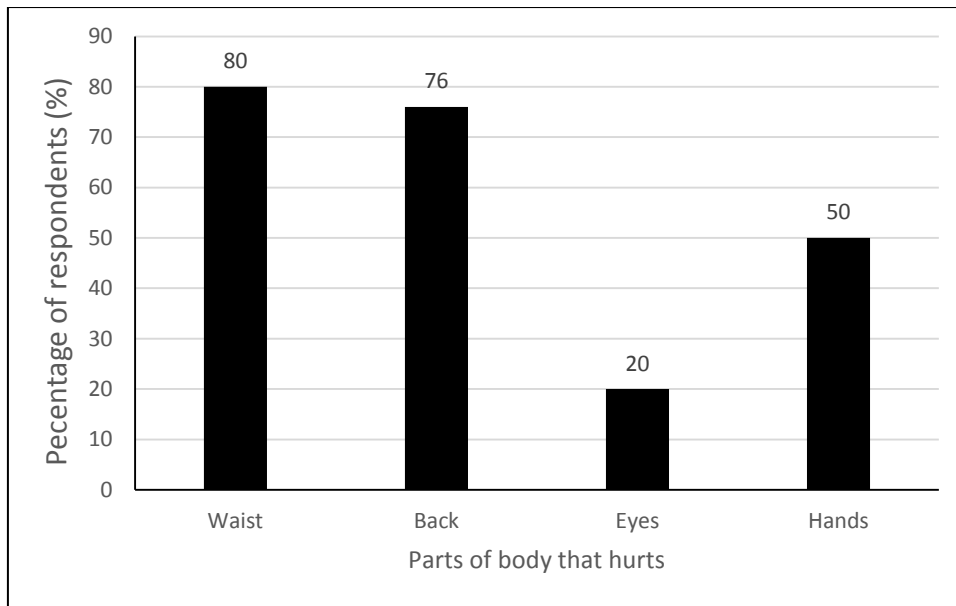


Figure 5. Parts of the body aches during sorting and grading of tomatoes

Noting that most of the respondents experienced hurts in more than one part of their body at the same time during sorting operations. The results show that 80% of the respondents experience waist pains, 76% experience backaches, 20% experience eyes fatigues and 50% experience hand pains during sorting. It can be deduced that waist pains and backache are the most critical parts of the body that hurts during the sorting and grading of tomatoes. It can therefore be concluded that sorting and grading machine which can sort and grade fruits and vegetable with little human efforts will go a long way in alleviating the process. And the ergonomics design of the machine should take the waist and back comfort of the operator into consideration.

3.6 Duration of sorting tomatoes

Figure 6 shows the average time taken for sorting tomatoes during glut and lean production periods for different sizes of baskets.

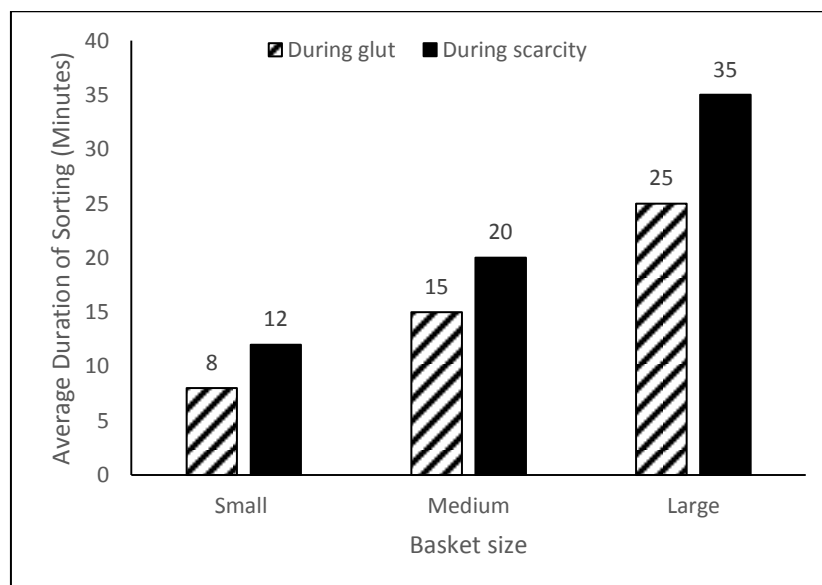


Figure 6. Average time of sorting tomatoes at glut and lean production periods

The sorting time ranged between 8-25 minutes and 12-35 minutes for the glut and lean period respectively. The results show that the sorting time of tomatoes increases with the increase in the size of the basket, and the sorting time was found to be more during the scarcity period than at glut. This

can be as a result of plenty of bad tomatoes present in the lots during the lean period that required to be scrutinized. Hence, the work is more demanding and required more time. Therefore, interventions such as sorting machines are needed in the industry to ease the process.

3.7 Cost of Sorting Tomatoes

The costs in Naira of sorting tomatoes during the glut and lean production periods are presented in Figures 7.

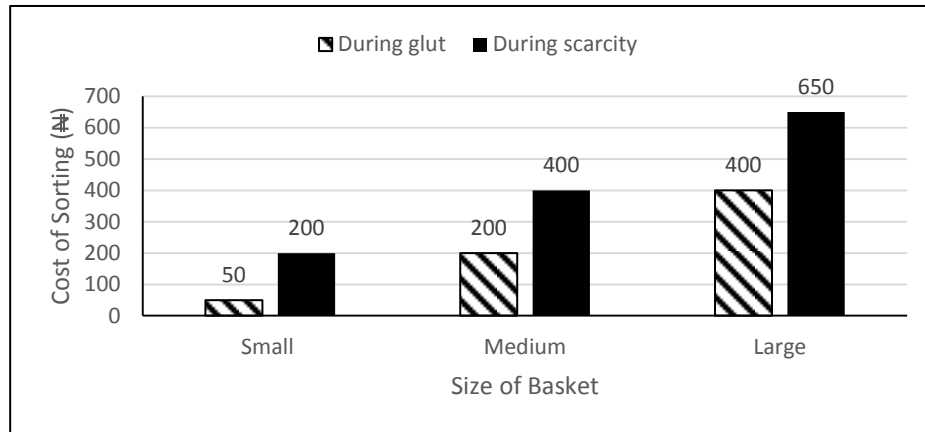


Figure 7: Cost of sorting tomatoes at glut and lean periods

The costs ranged between ₦50 to ₦400 and ₦200 to ₦600 for glut and lean periods respectively. The results show that the cost increase with the size of baskets and the cost of sorting during the lean period is higher than the cost of sorting during the glut period. Mean costs of sorting tomatoes were ₦125, ₦300 and ₦525 for small (20 kg), medium (45kg) and large (65kg) baskets respectively. The higher cost of sorting during the lean period of tomatoes can be ascribed to the difficulty of the work and the lack of labour to do the sorting at that time.

3.8 Factors consider most in purchasing tomatoes

The responses on the various factors put into consideration by buyers of tomatoes in the market are presented in Figure 8.

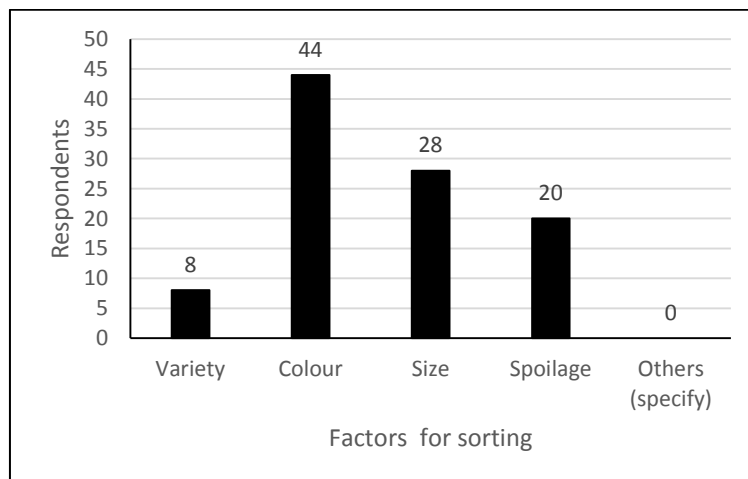


Figure 8. Factors considered for sorting tomatoes buyers

The study shows that variety, colour, size and spoilage of tomatoes are the factors that are considered by buyers of tomatoes. The results show that 8% of the respondents considered variety of tomatoes, 44% considered colour of tomatoes, 28% considered the size of tomatoes and 20% considered spoilage of tomatoes. This shows that colour, size and spoilage of tomatoes are very important factors to be considered by tomato processors and engineers who are interested in designing sorting and grading mechanisms for the product.

3.9 Varieties of tomatoes

Figure 9 presents the varieties of tomatoes mostly grown in the study area. The results show that, 64% grow Roman VF, 25% grow UC 82-B and 11% grow other varieties of tomatoes.

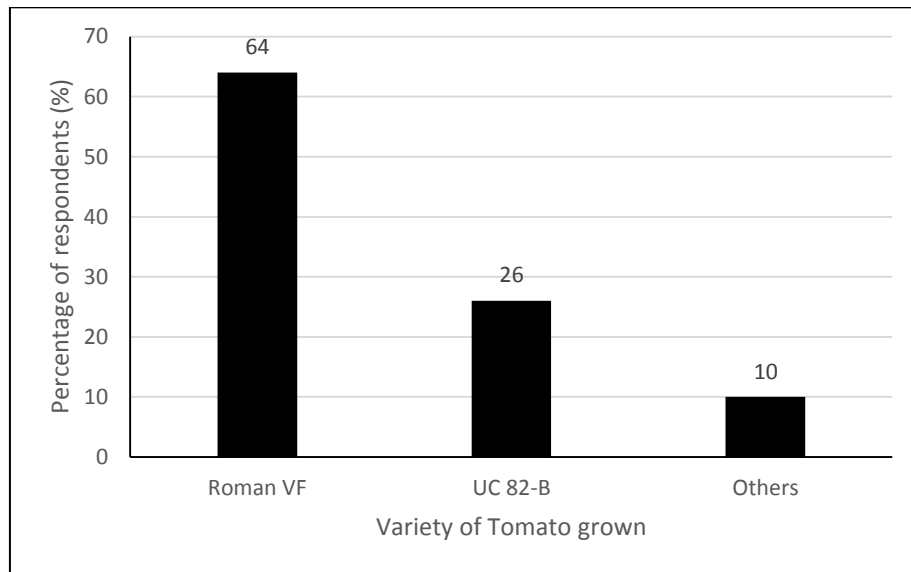


Figure 9. Varieties of tomato grown

The other notable types of varieties grown in the area are; Capullal (Cocktail), Capullal (Beef) and Divar. The study revealed that Roman VF is the highest grown tomato variety in the area. This may be because Roman VF is more tasty and the habitat likes tasty foods. Therefore, in the design of processing equipment such as sorting and grading machines for tomatoes in this area, properties of Roman VF variety and UC 82-B should be given consideration.

3.10 Physical Properties of Local Varieties of Tomatoes Pertinent to Sorting and Grading

Using 50 samples each, the physical properties of three varieties of tomatoes (Roman VF, UC-82B and Divar) available locally were determined and presented in Table 2 – 4. It is evident that the Roman VF has the highest mean length of 62.63 mm this is followed by Divar (57.89 mm) and UC -82B (50.90 mm) has the lowest mean length of fruits. The mean length of fruits in this study is close to the 50.45 mm length of fruit obtained for red tomato fruits but less than 70.73 and 74.53 mm obtained for yellow and green tomato fruits respectively [8]. The results revealed that the Divar has the highest mean thickness of 43.29 mm the next in thickness is UC -82B (38.03 mm) and Roman VF (19.69 mm) has the least mean thickness of fruits. Thickness obtained for Divar is less than 56.12 mm measured for Riogrand tomato. While the thickness of Orbana tomato and that of Cherry tomato are very similar to those of UC -82B and Roman VF tomatoes respectively [11]. The results showed that the UC -82B has the highest mean values in most of the physical properties studied. UC-82B has the highest width, weight, arithmetic mean diameter, geometric mean diameter, aspect ratio, sphericity and surface area with 53.63 mm, 0.25 kg, 52.27 mm, 51.00 mm, 96.35, 0.92 and 9637 mm² respectively. The mean values here were within the range of those obtained for Riogrand, Orbana and Cherry tomatoes [11]. This implies that sorting and grading machine designed with the dimensions of the aforementioned foreign tomatoes varieties can also work for UC -82B tomatoes variety. Postharvest processing of the tomato such as sorting, grading packaging and transportation required most of the parameters determined for effective system operations. The mean values of dimensions are employed for the size of the aperture required for machines needed for separating and also for producing boxes meant for handling and transporting the product. The aspect ratio and sphericity describe the shape of the fruits. This information helps to describe the type of movement that the fruits can exhibit during processing.

Table 2. Physical properties of tomatoes

Variety	Properties	Mean values	Min	Max	Standard Deviation	Variance
Roman VF	Length (L) (mm)	62.63	30.04	75.21	24.43	596.85
	Width (W) (mm)	37.89	22.35	53.43	7.34	53.87
	Thickness (T) (mm)	19.69	16.50	22.87	2.81	7.91
	Weight (kg)	0.063	0.0005	0.086	0.04	0.0014
	Arithmetic mean (D_a) (mm)	45.56	25.72	49.39	10.90	118.12
	Geometric mean (D_g) (mm)	34.50	24.80	44.20	8.70	74.91
	Aspect ratio (R_a) (%)	84.30	66.60	102	26.82	719.34
	Sphericity (S)	0.76	0.82	14.41	1.15	1.33
	Surface area (S_f) (mm ²)	4835	1932	6138	2071	4.28×10^6
UC 82-B	Length (L) (mm)	50.90	28.45	73.34	9.12	83.10
	Width (W) (mm)	53.63	30.45	76.80	11.83	140
	Thickness (T) (mm)	38.03	20.00	56.05	9.58	91.80
	Weight (kg)	0.25	0.001	0.50	0.5	0.25
	Arithmetic mean (D_a) (mm)	52.27	23.60	60.94	8.67	75.30
	Geometric mean (D_g) (mm)	51.00	29.40	72.60	13.64	186
	Aspect ratio (R_a) (%)	96.35	80.70	112	17.32	300
	Sphericity (S)	0.92	0.7990	1.0496	0.095	9.10×10^{-3}
	Surface area (S_f) (mm ²)	9637.00	2715	16559	5391	2.91×10^7
Divar	Length (L) (mm)	57.89	28.01	87.76	23	523
	Width (W) (mm)	48.35	30.61	50.09	65.70	4317
	Thickness (T) (mm)	43.29	29.80	56.78	7.94	63.10
	Weight (kg)	0.17	0.013	0.22	0.078	0.0061
	Arithmetic mean (D_a) (mm)	51.61	29.42	73.80	14	196
	Geometric mean (D_g) (mm)	48.84	23.34	60.33	8.72	76.01
	Aspect ratio (R_a) (%)	85.61	71.22	100	8.49	72.04
	Sphericity (S)	0.77	0.79	0.7570	0.14	0.02
	Surface area (S_f) (mm ²)	8572.94	1711.40	11434.48	2967.40	8.80×10^6

4 CONCLUSIONS

Studies on tomato sorting and grading in the tomato production cluster area of Kano State were carried out. The study shows that 88% of the tomato processors are young and active people whose jobs need to be enhanced because the young and the old population depend on them. Only 15% of the respondents have experience of 10 years and above, indicating the tediousness of the work that makes many people stop the work as they are ageing. A total of 87% of the respondents agreed that sorting and grading are very important and they greatly affect the sales of tomatoes. Variety, colour, size and spoilage of tomatoes are the factors that are mostly considered by buyers of tomatoes. UC-82B variety of tomato has the highest mean values in most of the physical properties measured, having a width, weight, arithmetic mean diameter, geometric mean diameter, aspect ratio, sphericity and surface area of 53.63 mm, 0.25 kg, 52.27 mm, 51.00 mm, 96.35, 0.92 and 9637 mm² respectively.

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