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Means of transportation affects the physical qualities of watermelon (*Citrullus lanatus* [Thunb]) fruit within the Tamale Metropolis in the Northern Region of Ghana

Authors: Yakubu V. A.
Tamale College of Education Box 1 ER, Tamale Ghana

Salifu A.
Tamale College of Education Box 1 ER, Tamale Ghana

Moses K. A .M
Tamale College of Education Box 1 ER, Tamale Ghana

Ibrahim N. I
Tamale College of Education Box 1 ER, Tamale Ghana

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Abstract
The high perishable nature of fruits and vegetables in the agricultural sector is a major concern to scientists and the various stakeholders along the value chain. Postharvest handling practices and transportation systems are some of the factors responsible for some postharvest losses. This study therefore sought to identify the various means of transport used by traders and also to assess the kinds of mechanical damage that confront watermelon fruits during transportation within the Metropolis. Field survey collected information on handling practices and the means of transportation. It revealed that the means of transport used by watermelon traders included Kia mini truck (0.80 t), Motor King (Tricycle) (0.45 t) Kia mini truck (1.5 t) and Mini Pickup truck (1.00 t). It was also observed that majority (35%) of watermelon traders used Kia mini truck while Mini Pickup truck was the least used (15%). It further revealed that Motor King (0.45 t) recorded the highest percentage of cracks (0.08%) while Kia mini truck (1.5 t) had the least (0.03%). Additionally, Kia mini truck (0.80 t) had the highest percentage of bruises (0.14%) while Kia mini truck (1.5 t) had the least (0.53%).
Keywords: mechanical injury, hinterlands, transport, cracks and bruises

1.0 Introduction

Watermelon (*Citrulllus lanatus* [Thunb]) is an annual plant which belongs to the family cucurbitaceae and is believed to have originated from South-Africa where a wild variety is still found growing. Candolle (1882) reported that there is evidence sufficient to prove that watermelon may be native to tropical Africa. The edible fruit is produced on trailing vines that may reach 4.6 m or more in length. Fruits vary in shape from globular to oblong. The rind colour varies in shades of green from pale yellow to almost black and may be solid, striped, or marbled. Fruits have a thin, firm outer rind, a layer of white-fleshed inner rind that may be up to about one inch thick, and an interior edible pulp containing seeds unless the variety is triploid. Pulp colour of most commercial varieties is some shade of red or yellow (Sackett, 1974).

In Ghana, watermelon is distributed throughout the country. The cultivation of watermelon is concentrated along the southern sector of the country (Greater Accra region, Ashanti region, Volta region, and Western, Central and Eastern region) with much emphasis on the coastal savannah plain of the southern sector of the country (Agbetiameh, 2006). Some of these areas include Ada, Weija, Kasoa, Ningo, Afienya, Tsopoli, Sege, Nsakena, Winneba, Potsin, Nkoranza, Todze, Sogakofe, Akatsi and Adidome. In addition to this, certain areas of the middle belt i.e. some parts of the Brong Ahafo region, Upper Volta and parts of the three northern regions is also under cultivation (Lamptey, 2010).

All over the world, more than 1,200 varieties of watermelons are produced, with between 200 and 300 varieties grown in the United States alone (National Watermelon Promotion Board 2003). There are four basic groups of watermelon varieties: Picnic, Ice-Box, Seedless, and Yellow-Flesh. The Picnic type is oblong in shape, have dark green skin/rind (with or without stripes), weigh 9-11 kg, and have red flesh (National Watermelon Promotion Board, 2003). This group includes varieties named Sangria, Fiesta, and Regency. In the Ice-Box group are varieties such as Sugar Baby, Petite Sweet, and Yellow Doll (National Watermelon Promotion Board, 1999). These melons are round, weighing 2.5-7 kg, can have either red or yellow pulp, and can have dark or light green rind (National Watermelon Promotion Board, 2003).Varieties such as Crimson, Trio, Farmers Wonderful and Honey Heart are seedless type of watermelons (National Watermelon Promotion Board, 1999). Seedless

watermelons weigh 4.5-11 kg, are oval to round in shape, have a light green rind with dark green stripes, and can have either red or yellow flesh. The melons in the "yellow-flesh" variety have yellow to bright orange flesh/pulp, are oblong to long in shape, weighing 4.5-14 kg, and have light green rind with blotchy stripes (National Watermelon Promotion Board, 2003). Desert King and Tender Sweet are all yellow-flesh type watermelons (National Watermelon Promotion Board, 1999). Andrus (2005), has also listed some popular varieties of watermelon in the world these are sweet princes, crimson sweet, improved shipper, jubilee, Charleston gray, Charleston sweet, Sugar Baby and Special White.

Watermelon has been associated with a number of health benefits. Studies have shown that lycopene has the potential of reducing the risk of cancer of the lungs, prostate, colon and stomach (Giovannucci, 1999). Additionally, the risk of developing heart attack and other cardiovascular diseases has been shown to be reduced by lycopene (Fuhrman *et al*., 1997; Kohlmeier *et al.,* 1997) possibly due to its high cholesterol reducing effects. Apart from lycopene, other beneficial phytochemicals and antioxidants such as, carotenoids, Vitamin C and beta-carotene has been indicated to be present in watermelon (Erhardt *et al*., 2003).

Vitamin C for example helps prevent infections and viruses, and also helps slow the aging process and development of cataracts (National Watermelon Promotion Board, 2003). In addition, vitamin C aids in strengthening blood vessels and bones as well as help repair damaged tissue and heal wounds (National Watermelon Promotion Board, 2003).Vitamin C is also an essential nutrient for humans because it plays a crucial role in the synthesis of collagen in addition to protecting against oxidative damage. Vitamin C consumption has also been shown to protect against cancers of the mouth and lungs, improve cholesterol, and prevent scurvy (Fontham *et al*., 1988; Block, 1991; Ness *et al*., 1996). Small amounts of potassium, which can help alleviate muscle cramps, along with calcium and iron are also found in watermelons (National Watermelon Promotion Board, 2003).

The term quality is best defined according to the end user. When used in respect to plant produce, quality often describes the characteristics; attributes and value (intrinsic and extrinsic) of a plant produce which makes it acceptable to the end user. The quality of the watermelon fruit therefore refers to all the factors or characteristics of the fruits that contribute to the consumer's acceptance of the commodity. According to Williams (1999), high quality watermelon fruits should have a good soluble solid content of ten percent or more in the flesh near the centre of the melon fruit. The United States (US) standard for grades of watermelon as observed by USDA (1979) revealed that watermelon fruit with 81% total soluble solid is considered as having good internal qualities. Consumers consider many factors before they demand for the watermelon fruits. These include sweetness, sugar content, moisture content, total acidity, fruit juice, absence of bruises, surface abrasions and cracks among others (USDA, 1978).

The total soluble solids (TSS) content of the fruit flesh is an important property for quality. Total soluble solids is most often than not associated with the sweetness of the fruit and is sometimes used as one of the main quality parameters in determining maturity (Wills *et al*., 1981; Tian *et al*., 2007). The total soluble solid content of the melon fruit is mainly sucrose and fructose which is measured by a refractometer (Brix Equivalent). Generally, total soluble solid content of 8% is considered as marginal, 10% is acceptable and 12% or more means excellent. The Standards for determining maturity of watermelon is based on the level of soluble solids (Wills *et al*., 1981). According to Maynard (2001), sweetness is one of the prime quality factors in watermelon fruit and it is related to total soluble solids. The total soluble solids of watermelon decreases during respiration and it is also broken during ripening. Respiration is the oxidative breakdown of more complex materials such as starch, sugar and organic acids into simpler molecular carbon dioxide and water. Pincha (1988) reported that the soluble solid content of watermelon varieties such as crimson sweet is 10.2º Brix and that of Florida Giant variety is 9.6º brix, which is due to the fact that these watermelons are usually grown during the rainy season.

The test that measures all the acids present in a given fruit is referred to as total titratable acids (TTA) whereas pH is a measure of the strength of these acids. The pH level is used to determine acidity in foods. The pH level of 7 is considered to be neutral. Food substances with pH levels lower than 7 are acidic and food substances with pH level higher than 7 are basic or alkaline. The pH level depends on the fruit variety and the growing conditions such as the soil. The pH value of the watermelon fruit juice is considered as a sign of the fruit maturity (Avgi Soteriabu, 1969). At pH level of 9.0, watermelon becomes highly alkaline. According to Williams (1999), one way of exact field maturity of the watermelon fruits from the point of view of the pH level is to randomly harvest a few of the watermelons and test their sugar to acid ratio using the digital refractometer. The pH of the fruit juice is extracted and measured, 10 ml of the sampled juice extract is treated with 40 ml distilled water, the electrodes is simply pushed into the sample and measured under stirring and when the physic-chemical composition of the watermelon drift value set on the titrator has been reached, the pH value is shown automatically. Watermelons have a comparable slightly acidic pH range of about 5.2 to 5.6 (FAO, 1989). The pH level is one of the main criteria for assessing the safety of products. The acid in the juice helps to prevent the growth of bacteria which are dangerous. According to FAO (1989) watermelon that are unripe have higher pH value and at complete maturity stage the acid content decreases equally causing reduction in the pH level

because the acid content of fruit juice is directly related to the pH level. (Salman *et al*. 2008) reported that the acid content as well as the pH level of the fruit juice of watermelon do not usually increase any further after the produce is harvested from the parent plant. A related study by (Azudin *et al*., 1989) revealed that watermelon fruits usually do not acquire a sour taste after harvest and during storage which implies that the total acidity and pH level of the fruits remains relatively stable at harvest. The pH value of the watermelon fruit juice remains fairly constant during senescence and it is related to spoilage of the fruit (Gartner *et al*. 1967).

The moisture level of the watermelon is on the average of 92% (Hayes, 1987; USDA, 2003). Fresh harvested fruits and vegetables are mostly made up of water with most of them having 90-95% moisture content. Water lost after harvest is one of the most serious postharvest conditions consequently, special efforts are required to reduce the effects of these naturally occurring processes if quality of harvested fruits in the field will be the same at the consumer level.

The flesh crispness of the watermelon fruit is associated with high moisture content (Sergent, 2000). According to FAO (1989), respiration is a reaction of all plants both in the field and after harvest. Fresh produce continue to lose water after harvest and therefore the water content of the fruit at harvest must be used up. At complete maturity stage, the moisture content of the fruit is reduced and this affects the weight of the fruit. The loss of water in the fruit is due to lose of water vapour through the stem scars, stomata, and epidermis of the fruit. Maximization of water loss of the fruit can be achieved through the waxy layer of the outer layer surface of the fruit (Kays, 1991). Harvesting is the process of detaching the fruit from the main plant. During harvesting it is very important that appropriate precautionary measures are fully employed to ensure that fruits do not sustain cracks, scratches and other physical blemishes. Some of these measures include; harvesting fruit during the coldest time of the day to maintain low product respiration and prevent excessive loss of water through transpiration, wounding, bruising, crushing or damage from human and harvesting equipment should be avoided and the harvested produce should be kept in a cold storage facility as soon as possible. Postharvest handling practices are the practices that ensure that the integrity of the produce are not compromised from the time of harvesting to the time the produce gets to the final consumer (Lamptey, 2013). Some of the postharvest practices that are employed in watermelon production may include the following pre-cooling for rapid removal of heat to achieve effective quality preservation. According to (Thompson, 2000), pre-cooling methods include room cooling, force-air cooling, water cooling, vacuum cooling and packaging icing.

Injuries generally occur during transport with the interaction of the road and vehicle suspension system. The vibration caused during transport is semi-random occurring across a large range of frequencies and with jolts and bumps in the road adding to the background vibration (Hilton, 1994). The irregular nature of vibration input makes it difficult to define a thresh-hold for vibration damage. Fruits would vibrate when the frequency of the vibration reaches a certain level if the resonance frequency of the fruit colour is the same as the excitation frequency of the vehicle or road. The acceleration of the fruit can be considerably increased due to the resonance and thus severe damage can result (Sitkel, 1986). In stacked or palletized produce, the vibration can be directed up through the stock and thus increasing in magnitude at the higher level (Sitkel, 1986).

The main types of damage to fruits are bruising and tearing of skin (external and internal damage) (Mohsenin, 1987). The modulus of elasticity is a very important mechanical property of fruit and its variation can be described as internal damage in transportation (Ogut *et al*. 1999). The damage is always greatest on the top layer of the fruit and under severe transport condition it may extend down one, two or three layers (O'Brien and Gulloui, 1961). Watermelon requires extensive handling during harvest and market distribution and because of their weight and size proper care is required during handling. Carelessness during transit results in surface abrasion and damaging impacts to the watermelon. Serious impacts will cause external and internal damage which is characterized by cracks in the fleshy tissues that will be undetected until the watermelon is cut open. Postharvest losses are losses that occur from the time of harvest to the time the produce gets to the final consumer. The types of postharvest losses that occur in perishables and watermelon include; colour change, flavour change, physical damage, rot, insect and rodent pest attack and pathological disorders. Watermelon has normal dark green colour and change in that colour can lead to the outright rejection of the watermelon by consumers and this represents a loss to the producer. Francis (1995), stated that colour influences other sensory characteristics, which subsequently influences food acceptability, choice and preference. Colour of a product is unacceptable to a consumer, the flavour and texture may not be considered at all (Francis (1995). Colour may also be used as an indicator to determine the types and quantities of various carotenoids. In watermelon the sugars and organic acid determines the taste of the fruit however, the complex interaction of sugars, organic acids, phenolics and more specialized flavour compounds such as alcohols, esters, aldehydes determine the flavour of fruits. If a watermelon fruit does not conform to the normal taste or for instance there is a reduction in sweetness, consumers will not buy such products (Ofosu-Anim, 2009).

Pathological disorders in watermelon arise because of disease conditions. Affected fruits normally begin to rot sooner than their expected shelf life. Sometimes pathogens release poisonous substances known as mycotoxin into fruits making them unsafe for consumption. A diseased fruit is sometimes unattractive and may appear

abnormal however, it should also be noted that some diseased fruits might appear normal and look good until senescence sets in (Ofosu-Anim, 2009). These damages predispose the fruit to microbial attack and hasten deterioration. Physical damage represents a qualitative loss because no one will buy watermelon with cuts or cracks. The rejection of such fruits with defects is a loss due to quality compromization (Ofosu-Anim, 2009).

Physical damage in watermelon includes; mechanical injury, chilling injury, cracks, bruises, and abrasion. Mechanical injuries on the fruit sustained during handling are the main reason for considerable decline of fresh fruits and vegetable production. Waste due to damage in the chain between growers and consumers is estimated to be around 30-40% (Peleg and Hinga 1986). Rough handling during harvest, loading, and unloading of watermelons will result in fruit bruising, cracking, and high amounts of postharvest loss. Internal bruising leads to premature flesh breakdown. Watermelons should not be dropped, thrown, or walked on, as internal bruising and flesh breakdown will occur, Postharvest Handling Technical Bulletin, (2003). Carelessness handling during transit result in surface abrasion and damaging, mostly internal, impact abrasion, compression and vibration damaged based on the type of force acting on the fruit. Vibration damage occurs when fruits are subjected to vibratory type of stimulus which cause impact abrasion and compression injuries. Vibration may cause only one of these types of damage or all the three. They are roughly handled during harvest, harvesting and unloading resulting in fruit bruising, surface abrasions, cracking and consequently high amount of post-harvest loss (Rushing *et al*., 2001). Improper handling and loading of bulk watermelons too often result in serious transit losses due to surface abrasion, bruising and cracking (Cartaxo *et al*., 1997). According to Lallu *et al*. (1999), vibration of the watermelon fruit during transport generally result in melon surface abrasion of the skin with a smaller amount of compression damage and little impact injury vibration. Injuries generally do occur during transport with the interaction of the road and vehicle suspension system. The vibration caused during transport is semi-random occurring across a large range of frequencies and with jolts and bumps in the road adding to the background vibration (Hilton, 1994). During transport, the stacked or palletized produce will vibrate which can be directed up through the stock and thus increasing in magnitudes resulting in damage to the fruits as surface abrasions, bruising and tearing of skin (external and internal) (Mohsenin,1987). Locally produced watermelons are readily available seasonally and have resulted in consumers demanding some freshness and quality on seasonal basis. The price received for watermelon produce is determined by quality at the market place. Different consumers perceived as a reflection of produce quality which are ranked in order of preference as, Crispness, freshness, taste, appearance and condition nutritive value and price. Excessive rough handling during harvest, loading and unloading of the watermelon fruits causes cracks. Poor and rough handling such as dropping of fruit, throwing the fruit and the fruits being walked on largely account for fruit internal bruising and flesh break down. According to Armstrong *et al.* (1977), watermelon requires extensive handling because of its delicate nature during harvest and market distribution and because of their weight and size; proper care is required during handling. Carelessness during transit can result in watermelon surface abrasion and damage to the internal layer.

During transportation on rough roads, damage to the watermelon fruit due to dropping vibration may not be seen in the outside of the fruit but will show up internally as water soaked areas that breaks down quickly (Martin, 1966).

According to (Horsfield *et al*.(1972b) due to their large size and susceptibility to splitting or cracking under mechanical stress, watermelon fruits should not be harvested in the early morning when they are mostly turgid as the modulus of elasticity of the fruit is adversely affected when the fruit is turgid and easily cracks. In Africa generally, the movement of watermelon from the farm gates to market place is accomplished by the use different types of vehicles irrespective nature once it has a compartment to contain the fruits.

1.1 Problem Statement

In Ghana, for instance, the bulk of the cultivation of watermelon is done in the hinterlands and transported to the urban markets for sale. The means of transportation employed affect the quality of watermelons as they are transported within an average distance of 10-15 kilometers to the marketing centres. These means of transport used to convey the produce are generally in open trucks or inside un-refrigerated vans. These are not ideal for maintaining fruit quality. The fruits on top of the load in the open trucks are usually subjected to sun burns with fruits loaded inside enclosed vans subjected to overheating, especially if transportation occurs during a hot sunny afternoons, those fruits underneath the load are also subjected to weight and vibration impacts and shocks. It is against this background that this study was conducted to:

1. Identify the various means of transportation used by traders for transporting watermelon fruits from the farm gates to the marketing centres in the Tamale Metropolis.
2. Assess the kinds of mechanical damage to watermelon fruits during transportation to the marketing centres in the Tamale Metropolis.

Research Questions

1. What are the means of transportation used by traders for transporting watermelon fruits from the farm gates to the marketing centres in the Tamale Metropolis?
2. What are some kinds of mechanical damage to watermelon fruits during transportation to the marketing centres in the Tamale Metropolis?

2.0 Materials and Methods

The study areas were Kumbungu and Nyankpala, all in the Tamale Metropolis in Northern Ghana. These communities were selected because they contribute significantly to the quantity of watermelon produced and marketed in the Tamale Metropolis in Northern Ghana. To avoid being biased and to improve the validity and reliability of the study, the random sampling technique was employed to select 50 watermelon traders within the watermelon value chain for interview from the two communities. Primary data was gathered through interviews and administration of questionnaire. The field survey involved fifty (50) watermelon traders comprising two (2) male and forty-eight (48) female traders from the two communities. Open and close ended type questions were used in conducting the study ensuring that this captured various sections focusing on the means of transportation used and the associated damage. Prior to the questionnaire administration, focus group discussion was held to explain the purpose of the study and the questionnaire to the watermelon traders to facilitate the data collection process. The researcher visited the watermelon producing areas where harvested watermelon fruits were assembled in heaps. Sorting and selection was done to select fruits that had no physical blemish. Each watermelon fruit averagely weighed 3kg. These were loaded into the various capacities of the means of transports Tricycle (0.45 t) – 100 fruits, Kia mini truck (0.80 t) -150 fruits, Mini pick-up truck (1 t) – 250 fruits and Kia mini truck (1.5 t) – 300 fruits and conveyed across the study area within an average distance of (10 -15 km) with the same type of road conditions to the Tamale Metropolis. On arrival, the loaded watermelon fruits were offloaded and each fruit inspected to determine the kinds of mechanical damage. Field survey was analyzed using SPSS statistical software version 13 (USA)

Table 1 Demographic Information of Watermelon traders

Variables	Frequency	Percentage
Gender		
Male	2	4
Female	48	96
Age of respondents		
20-29	3	6
30-39	20	40
40-49	17	34
50 and above	10	20
Educational background		
Primary	7	14
SHS/JHS/Middle form 4	5	10
No formal education	38	76
Number of years in watermelon trade		
1-3	19	38
4-6	10	20
More than 7 years	21	42

Source: field data, November 2014

From the survey it was observed that (96%) of the watermelon traders were females while (4%) were males. In relation to ages most of the traders (40%) were between the ages of 30-39 years while (6%) of them were in the age range of 20-29 years. In terms of educational background, majority (76%) of the watermelon traders had no formal education while a few (10%) had SHS/JHS or middle school level. For working experience in the watermelon trade, 42% of the traders had been in the watermelon business for more than 7 years while (20%) had been in the business for between 4-6 years.

The researcher visited the watermelon producing areas where harvested watermelon fruits were assembled in heaps. Sorting and selection was done to select fruits that had no physical blemish. Each watermelon fruit averagely weighed 3kg. These were loaded into the various capacities of the means of transports Tricycle (450 Kg) – 100 fruits, Kia mini truck (800 Kg) -150 fruits, Mini pick-up truck (1Tone) – 250 fruits and Kia mini truck (1.5 Tones) – 300 fruits and conveyed across the study area within an average distance of (10 -15 km) with the same type of road conditions to the Tamale central market. On arrival, the loaded watermelon fruits were offloaded and each fruit inspected to determine various mechanical damages and the information recoded. This was later interpreted and presented in percentages.

3.0 Results and Discussion

From the survey (Table 1), it was observed that majority (96%) of the watermelon traders were females while 4% were males. This means there are more females in the watermelon trade industry an indication that the industry has a brighter future in terms of labour force, a key factor for growth and development of the industry. This confirms Zoraida *et al* (2004) work on Agriculture trade negotiations and gender where it is stated that women contribute significantly to food and agriculture production in developing countries and that they represent a substantial share of the agriculture labour force.

It revealed that most of the traders (40%) were within the age range of 30-39 years while a few (6%) of them were in the age range of 20-29 years. This means that the interest of the youth in agricultural livelihood is reducing. This is an indication of a future labour gap, a key factor in agriculture in general and in particular the watermelon industry. This is in line with the work of Mangal (2009) on investigation of some macro financial linkages where it is reported that there is insufficient youth participation in the agriculture sector.

It was also observed that majority (76%) of the watermelon traders had no formal education while a few (24%) of them had some level of education. It suggests that they may lack the basic knowledge to meet the challenges of postharvest losses. This situation poses danger to issues of postharvest losses and its effect on food security and safety concerns. This could also mean a challenge to the watermelon industry in the area of adapting new technology, a situation which requires time and resources to teach the watermelon traders to understand and adapt relevant postharvest handling techniques. This assertion confirms work on the effects of education on agricultural productivity under traditional and improved technology in northern Nigeria, where the outcome suggested that schooling not only enhances agricultural productivity following technology, but also promotes adaption (Arega and Manyong, 2006). Also, according to Gasperini, (2000), in 1992, the World Bank conducted a survey to measure the relationship between farmers' education and their agricultural efficiency in low income countries where it was discovered that farmers with formal education were more productive than farmers with no education.

With regards to working experience, as many as (21 representing 42%) of the traders had been in the watermelon trade for more than 7 years while a few (10 representing 20%) had been in the trade for 1-3 years. This indicates that there are more experienced traders with requisite technical expertise necessary for sustaining the development of the watermelon industry.

Research Question 1: What are the means of transport used by traders for transporting watermelon fruits from the farm gates to the marketing centers in the Tamale Metropolis?

The study examined the means of transport used by watermelon traders within the Metropolis. The results are presented in Table 2.

Table 2 Means of transportation employed by watermelon traders

Means of transportation	Number	Percentage (%)
Tricycle (0.45 t) – 100 fruits	15	30
Kia mini truck (0.80 t) - 150 fruits	10	20
Mini pick-up truck (1 t) – 250 fruits	7.5	15
Kia mini truck(1.5 t) – 300 fruits	17.5	35
Total	**50**	**100**

Source: field data, November 2014.

The table showed that the means of transport used by the watermelon traders included: Kia mini truck (0.80 t), Tricycle (0.45 t), Kia mini truck (1.5 t) and Mini Pickup truck (1 t). It also indicates that majority (35%) of watermelon traders used the Kia mini truck (1.5 t) while 15% used the Tricycle (0.45 t). From the table, it is clear that there is no consistent relation between the number of traders using a particular means and the tonnage capacity of the means of transportation. For example, even though, Kia mini truck (1.5 t) has the highest capacity of 1.5 t and accounted for the greater percentage (35%) of traders using it, Mini pick-up truck (1 t) with the second highest capacity had the least percentage (15%) of traders using it for watermelon transportation. In addition, Tricycle (0.45 t) with the lowest capacity had the second highest percentage (30%) of traders using it. This agrees with the work of Ida *et al* (2007) on Fruits and Vegetable Handling and Transportation in Nigeria where it's reported that due to transportation challenges faced by traders they tend to make use of whatever transport facilities are available to avoid deterioration of their produce.

The fact that Kia mini truck (0.80 t) was among the least (20%) patronized by traders could be due to high physical damage (cracks and bruises). On the other hand, Tricycle (0.45 t) with the lowest capacity was among the most dominant means of transport. This could be attributed to the fact that it is the readily availability means of transport within the study area. This is in agreement with Ida *et al* (2007) whose report on Fruits and Vegetable Handling and Transportation in Nigeria showed that the major problem encountered by traders of fruits and vegetables is the non-availability of the vehicles when most needed. As such they resort to the use of any kind of available vehicle, including passenger trucks, in order not to lose their produce.

Research Question 2: What are some of the mechanical damage that occurs during transportation of watermelon fruits to the marketing centres in the Tamale Metropolis?

The survey also investigated the kinds of mechanical damage associated with the transportation of watermelon using the identified means of transport. Table 3 shows the outcome of the survey.

Table 3: Mechanical damages encountered during transportation of watermelons

Means of Transport	Cracks	%	Bruises	%
Tricycle (0.45 t) – 100	8	0.08	12	0.12
Kia mini truck (0.80 t) - 150 fruits	10	0.07	14	0.14
Mini pick-up truck (1. t) – 250 fruits	10	0.04	20	0.08
Kia mini truck (1.5 t) – 300 fruits	8	0.03	16	0.05
Total	**36**		**36**	

Source: field data, November 2014

From the table, Kia mini truck (1.5 t) recorded the least damage in terms of both cracks (0.03%) and bruises (0.05%) while Kia mini truck (0.80 t) was recorded among the highest damages in terms of both cracks (0.07%) and bruises (0.14%) respectively. The fact that Kia mini truck (0.80 t) was among the most damaged could be the reason for the lowest patronage by traders within the Metropolis. This is at variance with findings by Ida *et al* (2007) on Fruits and Vegetable Handling and Transportation in Nigeria that due to transportation challenges, traders tend to make use of whatever transport facilities are available to avoid deterioration of their fruits and vegetables. Even though, tricycle (0.45 t) was among the most damaging means of transport in terms of cracks (0.08%) and bruise (0.12%), it was the dominant means of transportation. This could be due to the fact that it is the most readily available means. Interestingly, the capacity of the transportation means was inversely related to the cracking percentage. For example, Tricycle (0.45 t) carrying 100 fruits only recorded (0.08%) cracks while Kia mini truck (1.5 t) with the highest carrying capacity of 300 fruits recorded only (0.03%) cracks. This could be due to proper loading of the fruits and cautious movement to the marketing centres. This is in consonance with the work on Post harvest Care and Marketing Preparation reported by the Watermelon Technical Bulletin volume 6 (2003) that Watermelon harvest quality is retained by careful handling and transport, proper grading, and cool temperature storage.

4.0 Conclusion and recommendation

The study showed that Kia mini truck (0.80 t), Tricycle (0.45 t), Kia mini truck (1.5 t) and Mini Pickup truck (1.00 t) are the means of transport used in conveying watermelon fruits from the farm gates to the Tamale Metropolis. It also revealed that cracks and bruises are the major mechanical damage that affects the watermelon business in the Tamale metropolis in the Northern Region of Ghana.

It is hereby recommended that Kia mini truck (1.5 t) could be used by watermelon traders since it recorded the least mechanical damage (cracks and bruises) which are the major kinds of damage experienced. A research on post-harvest management of watermelon in Ghana should be conducted by other post-harvest researchers on general challenges facing the watermelon sub-sector in Ghana.

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