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FROM WASTE TO RESOURCE: PRODUCTION AND UTILIZATION OF IRVINGIA FRUIT PULP IN YENAGOA, NIGERIA

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Abstract: Irvingia species (commonly known as bush mango) are indigenous, multipurpose tree species native to West and Central Africa, valued primarily for their kernels which are traditionally used as soup thickeners and flavoring agents. While the kernels have historically received the most economic and nutritional attention, recent studies have highlighted the fruit pulp as an underutilized resource rich in vitamin C and other nutrients. The pulp of Irvingia gabonensis (the sweet variety) is widely consumed as a dessert fruit and has been reported as a suitable raw material for producing jam, jelly, and juice. Additionally, the pulp and peel residues have potential applications as livestock feed, thereby broadening the species' relevance beyond household consumption to agro-industrial uses.

Despite these emerging uses, the fruit pulp is often discarded during kernel extraction, generating significant agricultural waste. This presents both an environmental concern and a missed opportunity for value addition within local and global food systems. Harnessing Irvingia fruit pulp waste for industrial processing could provide raw materials for food manufacturing industries while supporting sustainable waste management and local economic development.

This study assesses the yearly production and utilization of Irvingia fruit pulp waste in Yenagoa, Bayelsa State, Nigeria, with the aim of quantifying its availability and exploring its potential for industrial applications. Findings are expected to underscore the economic importance of Irvingia spp beyond kernel extraction and highlight opportunities for investment in value-added processing. By documenting the scale of pulp waste generation and its current uses, this research contributes to strategies that can transform agricultural by-products into valuable resources, reduce environmental burden, and enhance livelihood opportunities in Nigeria and across West Africa.

Keywords: Irvingia spp, Fruit pulp waste, Value addition, Utilization, Nigeria

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INTRODUCTION

Irvingia spp commonly referred to as bush mango are important, highly valued, indigenous multipurpose tree species found in West and Central African countries. *Irvingia* spp is basically harvested for the utilisation of the kernels gotten from the fruits which is used for soup thickening and flavoring. However recent studies have shown that the juicy fruit pulp produced by *Irvingia* spp is rich in vitamin C and is widely reported to be consumed as a dessert fruit or snack throughout Western and Central Africa. It has also been reported that *I. gabonensis* (the sweet variety of *Irvingia* spp) pulp is been used for making jam, jelly and juice. The fruits are sometimes used as livestock feed, especially. This recent discovery of the usefulness of the fruit pulp which usually constitute the bulk of waste produced by harvesters from the processing of *Irvingia* spp can now be an area of interest to food manufacturing companies all over the world. This study is centered toward bringing to limelight the availability (in quantity) of *Irvingia* spp fruit waste which is a potential raw material for the production of jam, jelly, juice, livestock feed and many more in Yenagoa, Bayelsa State, Nigeria.

2. MATERIALS AND METHODS

2.1. STUDY AREA

This research was carried out on three different communities; Agudama-Ekpetiama, Koro-ama and Yenegwe, in Yenagoa Local Government Area of Bayelsa State, Nigeria.

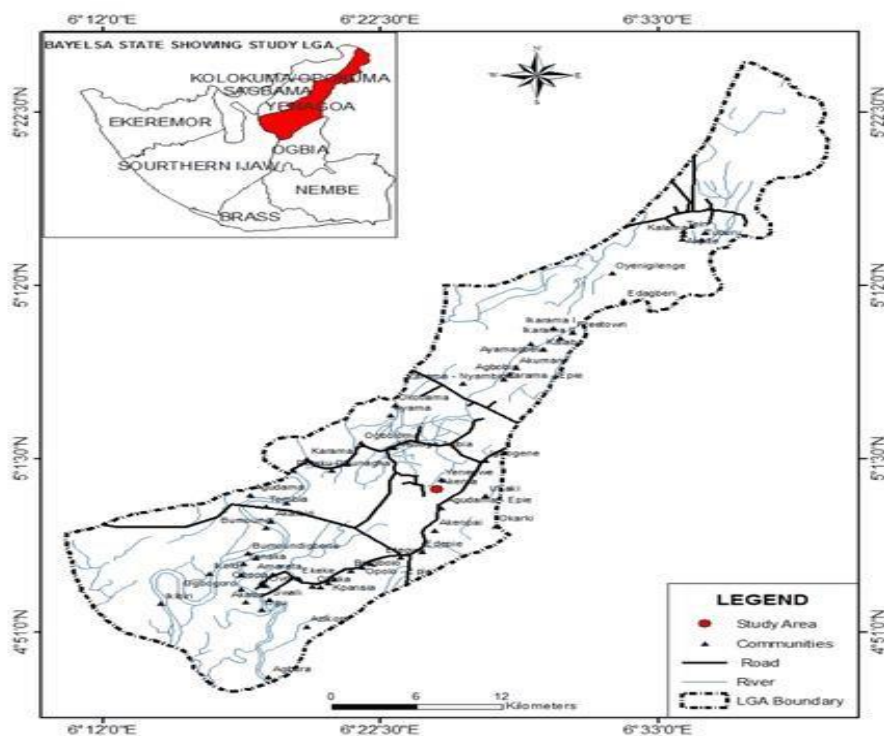


Figure 1. Map showing the sample sites, Yenagoa LGA.

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2.2. IRVINGIA SPP FRUIT WASTE



Figure 2. Fresh Irvingia spp fruit pulp



Figure 3. Irvingia spp fruit at a dumpsite

2.3. EXPERIMENTAL DESIGN AND DATA COLLECTION

Data for this research were obtained through the distribution of well structured questionnaires and one-on-one interviews with residents of the sample communities. A total of two hundred and ten (210), with a minimum of fifty (50) and a maximum of seventy (70) questionnaires for each sample community were distributed alongside one-on-one interviews. Questionnaires used for data collection were fifty six (56), fifty nine (59) and sixty nine (69) for each sample communities; Agudama-Ekpetiama, Koro-ama and Yenegwe, respectively.

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At the end of the distribution and one-on-one interview exercise, questionnaires were sorted according to each sample community. Then questionnaires for each sample community were further sorted according to gender and age range.

2.4. KEY NOTE:

Consumer respondent: A respondent who has consumed *Irvingia* spp fruit before.

Irvingia spp fruit and/or fruit waste and Kernel: The *Irvingia* spp fruit is the edible pulp while the fruit waste is the edible pulp which has not been eaten but discarded after the sharing of the fruit to reveal two white cotyledons known as the kernel.

Group: The male or female of any of the sample communities.

Unit of measurement for production: The material used as a base for measurement for this research work was the big custard rubber, which contains about twenty four (24) cups of freshly harvested kernel. A cup in-turn contains about sixty kernel with about 2.5g per kernel. The mean weight of *Irvingia* spp is 105.58g (Etebu, 2012; Etebu and Bawo, 2012; 2013). A fruit of *Irvingia* spp produces two kernel and two fruit wastes. Thus the amount of kernel and fruit wastes generated per annum can be extrapolated. The mean weight of freshly harvested *Irvingia* spp fruit waste used for this research work is 51.5g (per fruit waste) which is approximately 0.0000515 metric tons (t).

Period of consumption: The number of years a respondent has and/or have been consuming *Irvingia* spp fruit.

2.4. DERIVATION OF FORMULA

Average weekly production:

To get the average weekly production of *Irvingia* spp fruit waste and kernel produced by a respondent, per group, per community, in seven days (a week), the number of custard rubbers of kernel realized per trip by a harvester respondent in a particular group is first multiplied by the number of days in a week such a harvester goes for harvest. Thus, knowing the total production of kernel and fruit waste of each harvester respondent. Secondly, total production of each harvester respondent for each group (Male or Female) was summed and then divided by the total number of respondents in that group.

Mathematically;

Total individual production =

Number of custard rubbers realized per trip × Number of days harvester went for collection

Therefore; Average weekly production per respondent

Sum total of individual production per week per group

=

Total number of respondents in that group

Average annual production:

To get the average annual production of *Irvingia* spp fruit waste and kernel produced by a respondent, per group, per community, in the entire season (105 days or 15 weeks), the value for average weekly production per respondent is multiplied by the number of weeks in the harvest season of the fruit (15 weeks). This will give the value for the average annual production of fruit waste and kernel produced by each respondent, per annum.

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Mathematically;

Average annual production per respondent =

Average weekly production of respondent per group $\times$ Number of weeks in a harvest season

Average period of consumption:

To get the average period of years a respondent in a group must have consumed Irvingia fruit, the individual period of years of all consumer respondents is summed and then divided by the total number of respondents in that group irrespective of whether they have consumed the fruit before or not.

Mathematically;

Sum of individual years per group

Average period of consumption = _____

Total number of respondents in that group

Average daily consumption:

To get the average daily consumption of Irvingia spp fruit for each respondent in a group, the total number of fruits consumed per day by each consumer respondent is summed and then multiplied by the total number of respondents in that group, irrespective of whether they have consumed the fruit before or not.

Mathematically;

Average, daily, consumption = Sum total of number of fruits consumed per day by each consumer respondent

Total number of respondents in that group

3. RESULTS AND DISCUSSION

Irvingia spp were found to be indigenous trees in the three communities used as a case study in this research for Yenagoa Local Government Area, Bayelsa State. Thus, locals engage in harvesting of Irvingia spp fruits in the LGA. The annual production of Irvingia fruit waste and consumption of fresh fruits were evaluated in three communities. However, the percent of harvesters in each population recorded were; 58%, 57% and 37% for Agudama-Ekpetiama, Koro-ama, and Yenegwe respectively and this directly influenced the annual production of the fruit waste in these communities.

Irvingia spp were found to be indigenous trees in Yenagoa, Nigeria. Thus, locals engage in harvesting of Irvingia spp fruits in the area.

The average annual production of Irvingia spp fruit waste in metric tons (t) recorded for the three (3) communities; Agudama-Ekpetiama, Koro-ama, and Yenegwe, evaluated in this research work in Yenagao L.G.A were; 7,697.01 (t), 18,900.12 (t) and 1,681.62 (t) respectively. The amount of Irvingia spp fruit waste produced were observed to be greatly influenced by the differences in population/population of harvesters of Irvingia (Bush mango) in the individual communities. Likewise, the average annual production of Irvingia spp fruit waste in metric tons recorded for males of the individual communities; Agudama-Ekpetiama, Koro-ama, and Yenegwe, were; 4,319.00 (t), 9,551.37 (t), and 1,163.09 (t) and for the females, were; 3,378.00 (t), 9,348.75 (t) and 518.53 (t), respectively. The amount of Irvingia spp fruit waste were also observed to be greatly influenced by the differences in gender population/ population of their corresponding harvesters of the said fruit (Bush mango) in the individual communities. From results gathered in this research work, Koro-ama had the highest amount of Irvingia spp fruit

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waste produced per annual among its counterpart communities, Agudama-Ekpetiama and Yenegwe respectively in Yenagoa, Nigeria. Thou, to the best of my knowledge domestication of *Irvingia* spp were not encouraged by locals of the individual communities as majority of the *Irvingia* spp fruits were harvested and processed in the forest while only few were transported into town for processing. They (locals) generally treat the remains of the *Irvingia* fruit after the extraction of the kernel as waste. This may be related to the lack of knowledge about the industrial potentials, importance and uses of the fruit pulp of *Irvingia* spp.

Despite *Irvingia* spp been a seasonal fruit, biannual fruiting was also reported in some areas in Yenagoa Nigeria, once in January to February and then aging June to August.

The juicy fruit pulp of *Irvingia* spp, particularly *Irvingia* *gobonensis*, have been shown to be rich in vitamin C and has been reported to be consumed as a dessert fruit or snack throughout Western and Central Africa. Results from this study showed that, 69.6%, 72.8% and 68.1% of the entire population of Agudama-Ekpetiama, Koro-ama and Yenegwe respectively, are consumers of the fresh *Irvingia* spp fruit pulp.

Report gathered from this study also revealed that, with consumers given different reasons for the consumption of the fresh *Irvingia* spp fruit, majority of the population of the individual communities consumes the fruit as snacks particularly *Irvingia* *gabonensis* (sweet variety).

Locals also suggested that the fruit is also consumed for medical purposes, as it is believed to cure malaria, particularly *Irvingia* *wombolu* (bitter variety).

Report gathered from this research suggests that at an average, an individual eats about 4 ripe fruits daily.

Table 2. Shows the mean annual production of *Irvingia* fruit waste per gender, per community.

Koro-ama recorded the highest in the production with; 9,551.37 (t) and 9,348.75 (t), followed by Agudama-Ekpetiama with; 4,319.00 (t) and 3,378.00 (t) and lastly, Yenegwe with; 1,163.09 (t) and 518.53 for both Male and Female genders respectively (Table 2, Figure 5, Figure 6).

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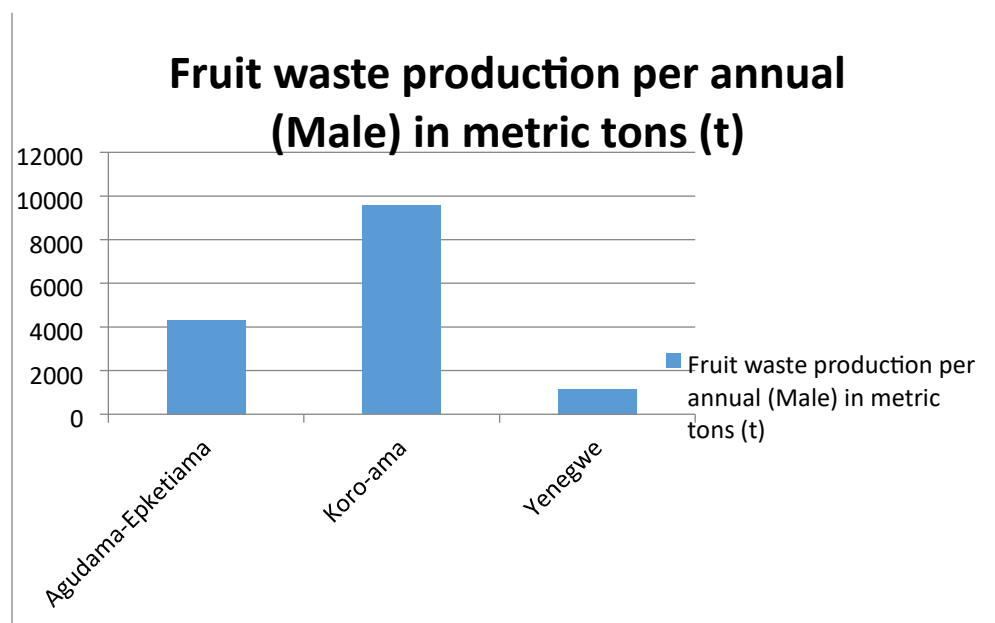


Figure 5. Mean annual production of Irvingia fruit waste by Males per community.

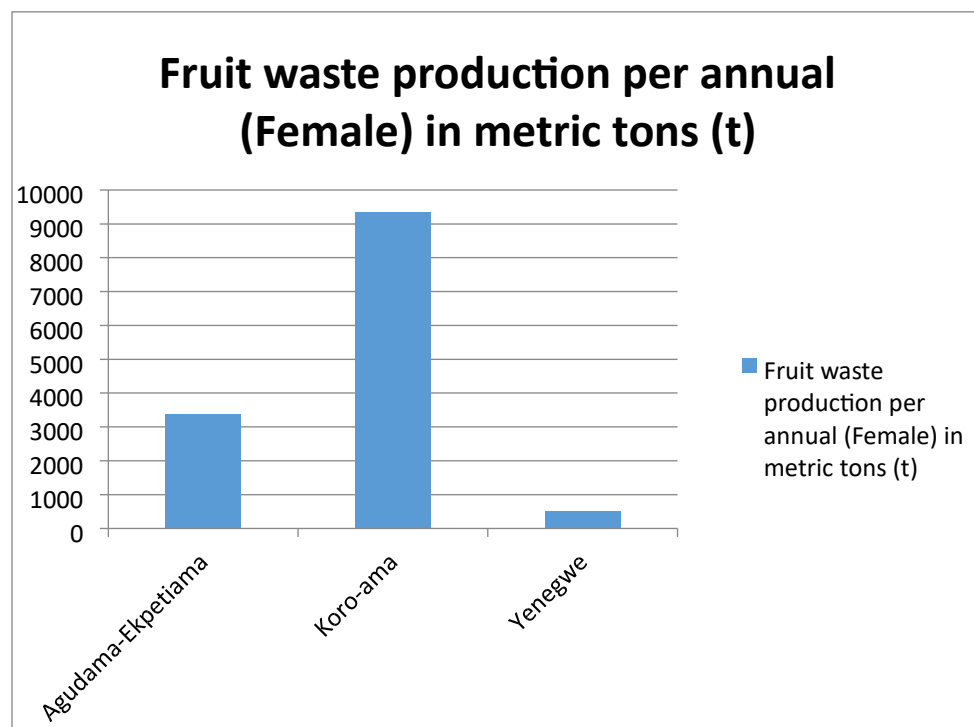


Figure 6. Mean annual production of Irvingia fruit waste by Females per community.

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The mean percentage population of consumers in the entire population of the communities varies and likewise the genders (Table 3).

Table 3. Mean percentage of population of fresh Irvingia fruit consumers with corresponding gender population per community.

Community Consumers (per community)	% Population of Consumers (per community)	% Population of Male Consumers (per community)	% Population of Female Consumers (per community)
Agudama-Ekpetiama	69.6	67	73
Koro-ama	72.8	77	65
Yenegwe	68.1	83	61

The mean percentage population of consumers of fresh Irvingia fruit was highest in Koro-ama with 72.8%, followed by Agudama-Ekpetiama with 69.6% and Yenegwe with 68.1%. For gender, the mean values for population of male consumers were; 67% and 73%, 77% and 65%, 83% and 61% for Males and Females in Agudama-Ekpetiama, Koro-ama and Yenegwe communities respectively (Table 3; Figure 7; Figure 8; Figure 9).

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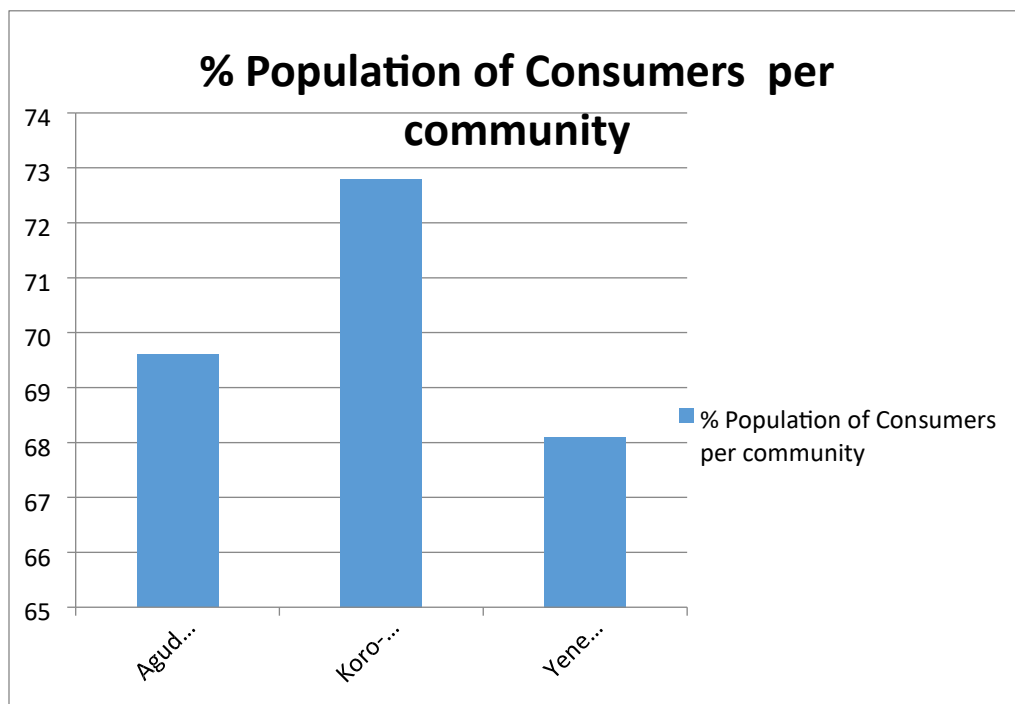


Figure 7. Mean percentage population consumers per community.

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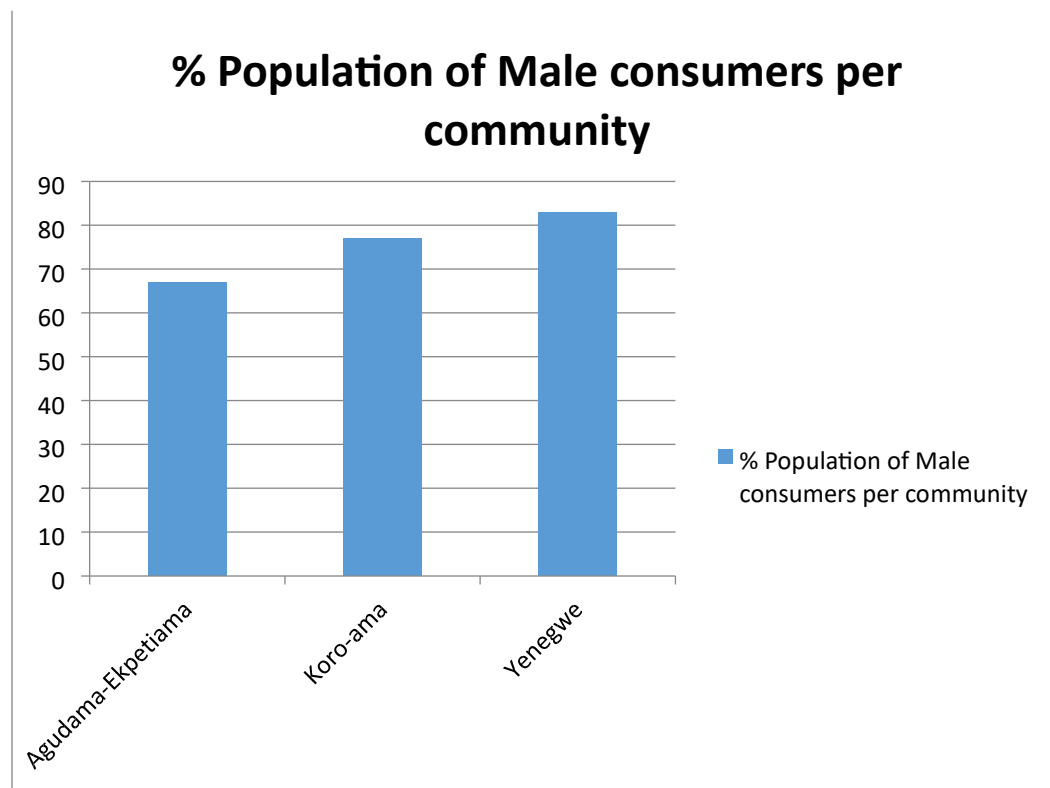


Figure 8. Mean percentage population of Male consumers per community.

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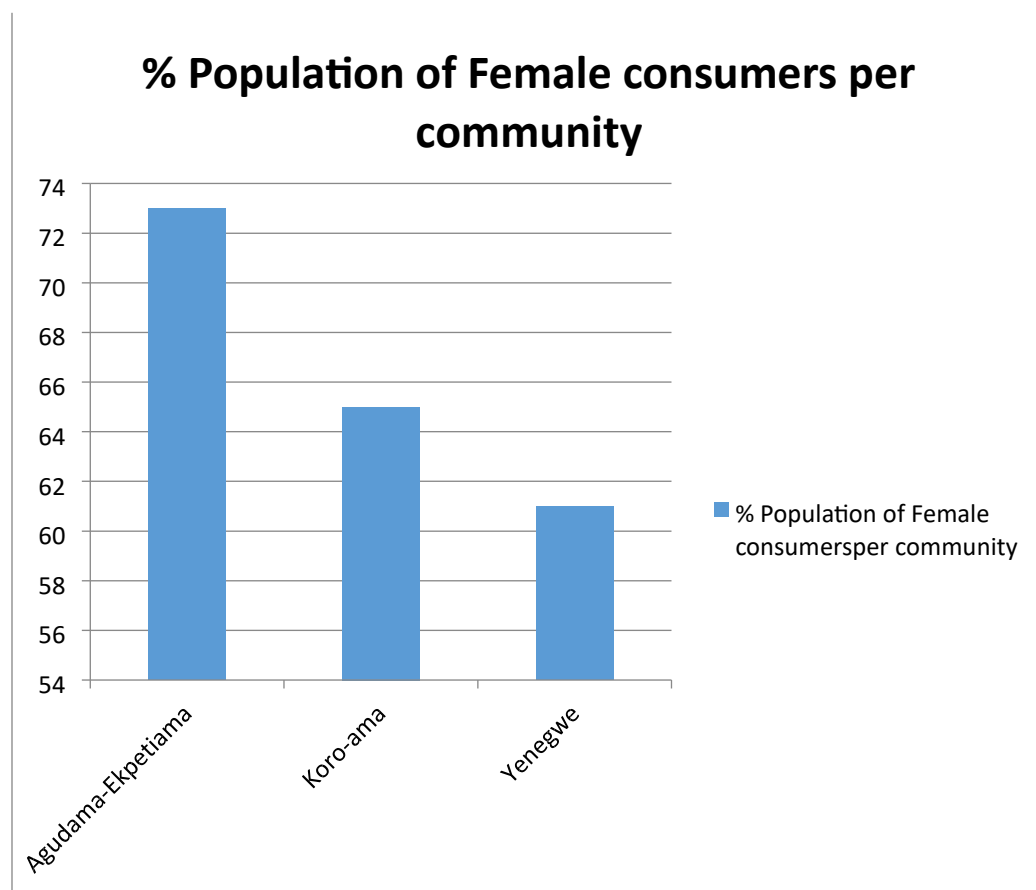


Figure 9. Mean percentage population of female consumers per community.

Different reasons were given for the consumption of fresh Irvingia fruit. Table 4. shows the mean values for the percentage population of each reason given in each community.

Table 4. Mean values for percentage population of reasons of consumption in each community.

Community	% Population per community (CAF)	% Population per community (CAS)	% Population per community (CAM)
Agudama-Ekpetiama	12.2	90	5
Koro-ama	27	75	17.5
Yenegwe	9	94	9

CAF = Consumed as Food, CAS = Consumed as Snack, CAM = Consumed as Medicine

The mean values for percentage population that consumes fresh Irvingia fruit recorded are;

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12.2%, 27% and 9%; 90%, 75% and 94%; 5%, 17.5% and 9% as Food (CAF), Snack (CAS) and Medicine (CAM) in Agudama-Ekpetiama, Koro-ama and Yenegwe respectively (Table 4. Figure 10)

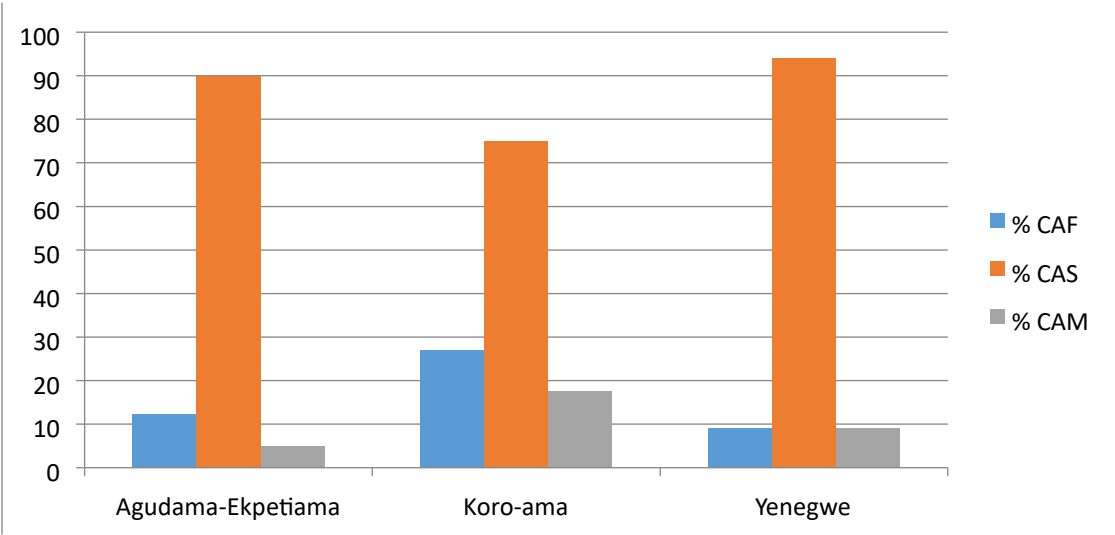


Figure 10. Mean percentage values for reasons of consumption across communities

Table 5. shows the mean values for percentage population of both male and female and reasons for consumption across communities.

Table 5. Mean values for percentage population of genders and reasons for consumption per community.

Community (CAF)	% Population of males (CAF)	% Population of female (CAS)	% Population of male (CAS)	% Population of female (CAM)	% Population of male (CAM)	% Population of female
Agudama- Ekpetiama	20	5	85	95	5	5
Koro-ama	23	31	73	77	20	15
Yenegwe	11	7	95	93	11	7

CAF = Consumed as Food, CAS = Consumed as Snack, CAM = Consumed as Medicine

The mean values for the percentage population of males that consumes fresh Irvingia fruit as Food, recorded across communities are; 20%, 23%, 11%, while females; 5%, 31%, 7%, for Agudama-Ekpetiama, Koro-ama and Yenegwe respectively (Table 5; Figure 11)

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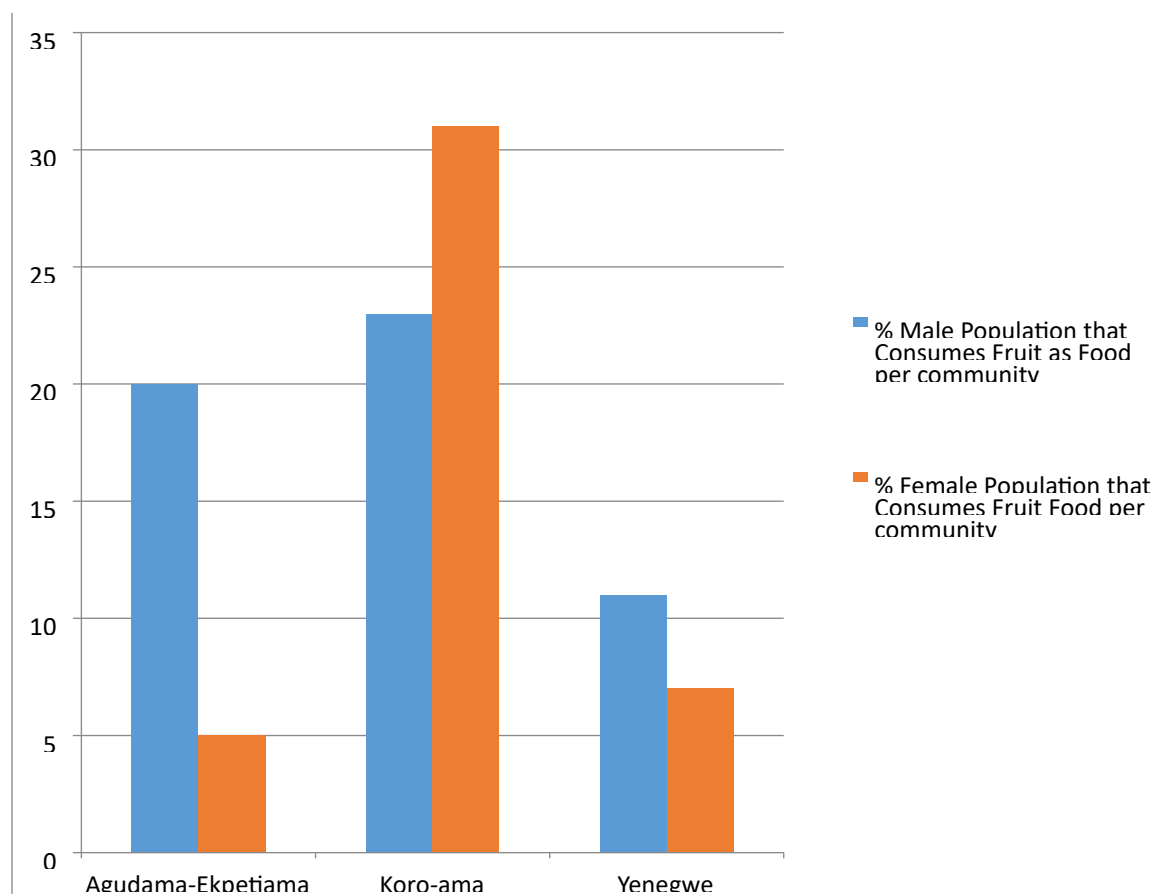


Figure 11. Mean percentage population males and females that consumes Irvingia fruit as Food across communities.

The mean values for the percentage population of males that consumes fresh Irvingia fruit as snacks, recorded across communities are; 85%, 73%, 95%, while females; 95%, 77%, 93%, for Agudama-Ekpetiama, Koro-ama and Yenegwe respectively (Table 5; Figure 12).

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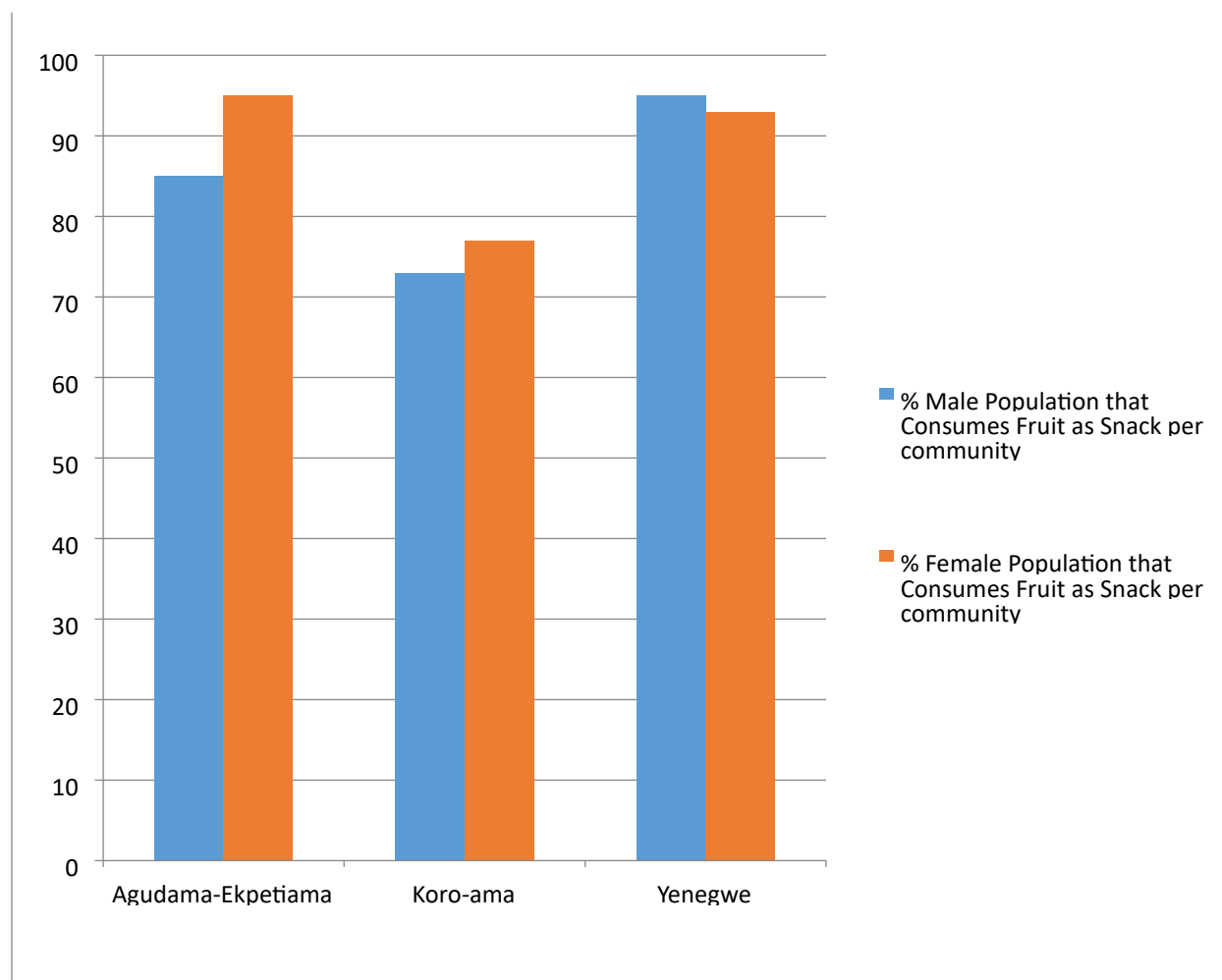


Figure 12. Mean percentage population males and females that consumes Irvingia fruit as Snack across communities.

The mean values for the percentage population of males that consumes fresh Irvingia fruit as Medicine, recorded across communities are; 5%, 20%, 11%, while females; 5%, 15%, 7%, for Agudama-Ekpetiama, Koro-ama and Yenegwe respectively (Table 5; Figure 12).

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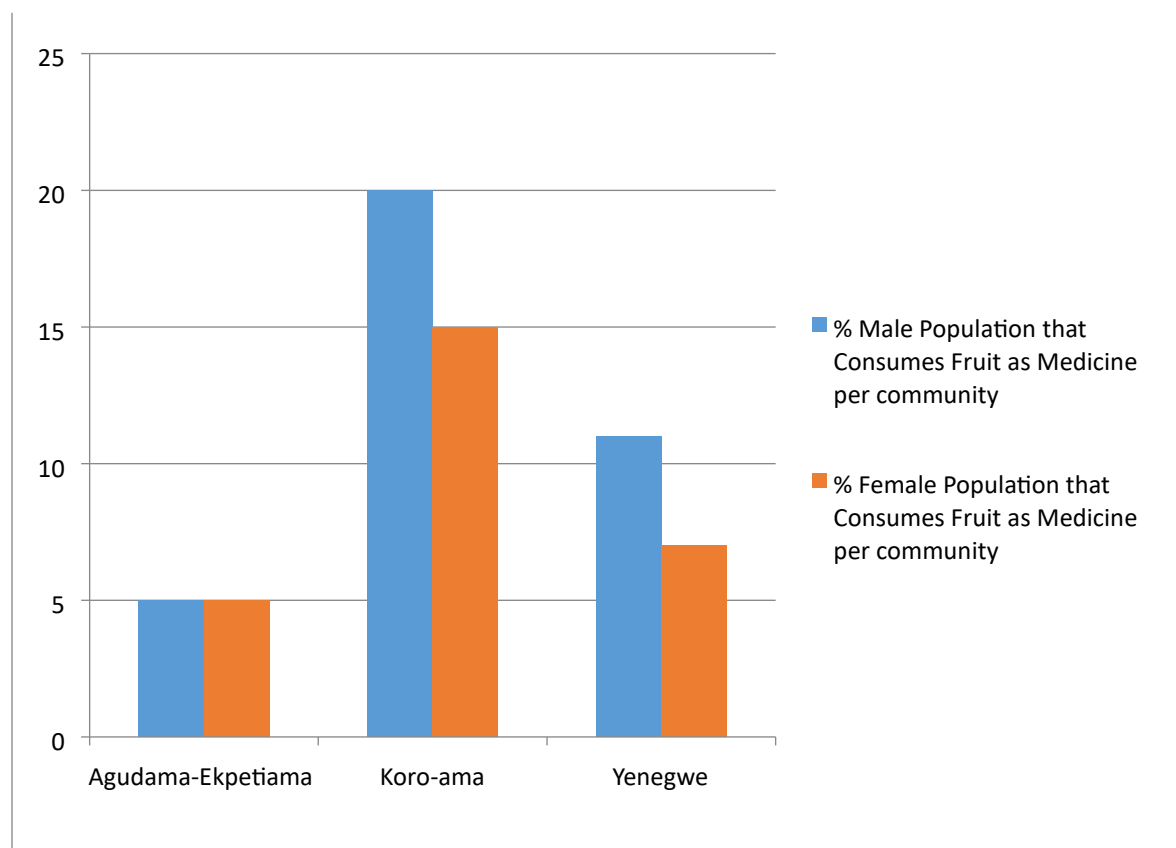


Figure 13. Mean percentage population males and females that consumes Irvingia fruit as Medicine across communities.

Table 6. Mean percentage population for categories of taste of Irvingia fruit in communities.

Community	% Population (TAVG)	% Population (TAG)	% Population (TAF)	% Population (TAP)
Agudama-Ekpetiama	5	64	2	10.3
Koro-ama	4.7	79.1	14	2
Yenegwe	6.4	59.6	21.3	12.8

Table 6. shows four categories for taste acceptability of fresh Irvingia fruit and the corresponding mean values of percentage population in each communities.

TAVG= Taste Acceptability Very Good, TAG= Taste Acceptability Good, TAF= Taste Acceptability Fair, TAP= Taste Acceptability Poor.

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The mean values of percentage population for the four categories of taste recorded were; 5% (Very good), 64% (Good), 2% (Fair) and 10.3% (Poor) for Agudama-Ekpetiama. For Koroama it is; 4.7% (Very good), 79.1% (Good), 14% (Fair) and 2% (Poor). While for Yenegwe it is; 6.4% (Very good), 59.6% (Good), 21.3% (Fair) and 12.8% (Poor), (Table 6; Figure 14; Figure 15; Figure 16).

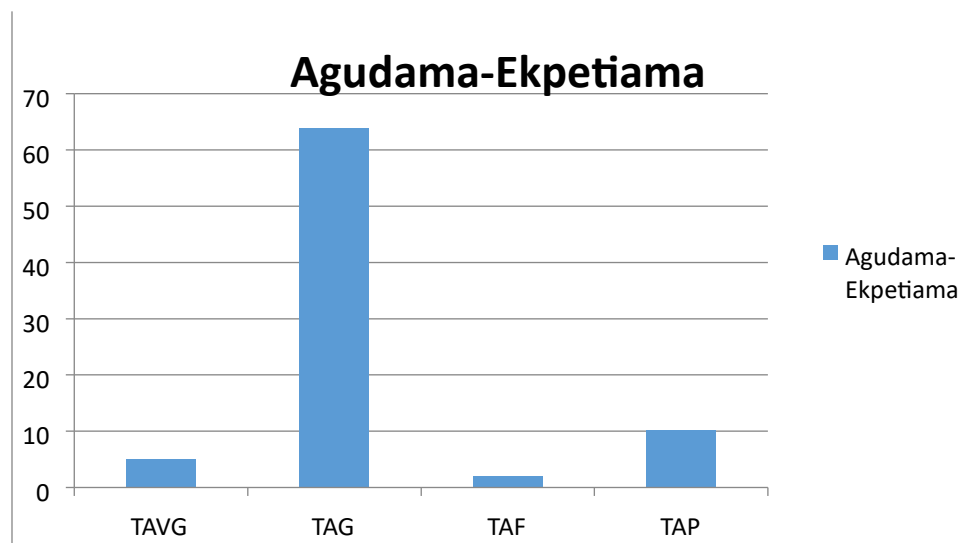


Figure 14. Mean percentage population for taste acceptability, categories; Very good (TAVG), Good (TAG), Fair (TAF), Poor (TAP) in Agudama-Ekpetiama.

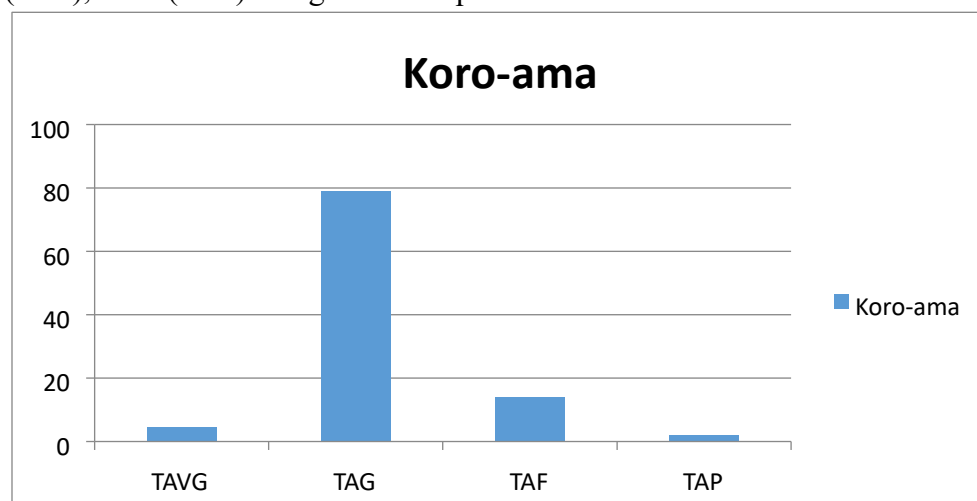


Figure 15. Mean percentage population for taste acceptability, categories; Very good (TAVG), Good (TAG), Fair (TAF), Poor (TAP) in Koro-ama.

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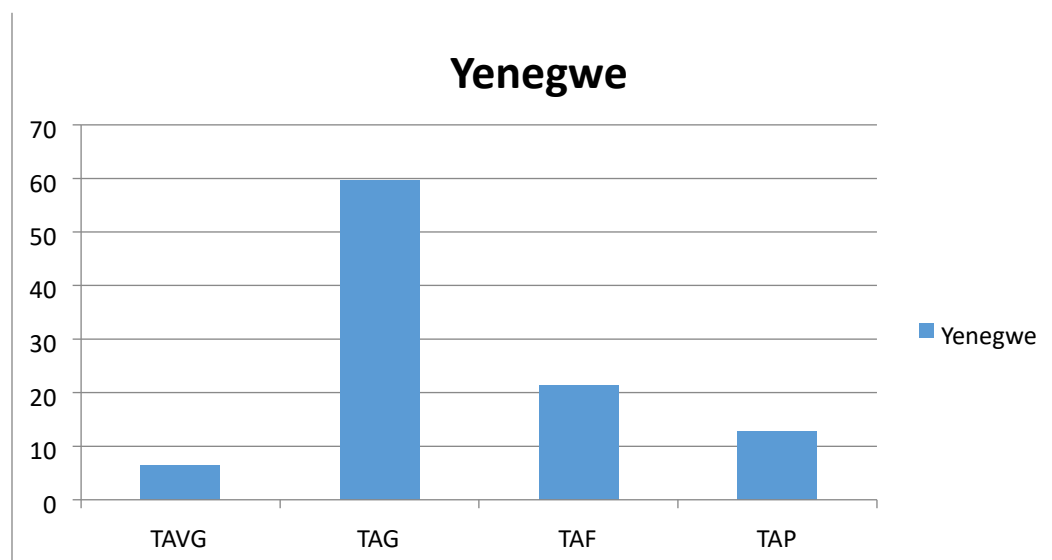


Figure 16. Mean percentage population for taste acceptability, categories; Very good (TAVG), Good (TAG), Fair (TAF), Poor (TAP) in Yenegwe.

CONCLUSION

Irvingia spp fruit wastes were found to be produced in large quantity in all three communities used as case study for this research in Yenegoa Local Government Area, Bayelsa State. Out of the three (3) communities, Koro-ama produced the highest quantity of fruit waste, followed by Agudama-Ekpetiama and lastly Yenegwe. It was observed that the quantity of fruit wastes produced in these communities were influence by the total population of harvesters in each community. Also, the quantity was observed to be influenced by urbanisation. It was also revealed that about half the percentage of the population of the sample communities were consumers of fresh *Irvingia* fruit pulp with an average daily consumption of about four (4) to five (5) fresh fruit per individual. Thus, the findings of this research provided us with the average annual production and consumption of *Irvingia* fruit waste and fruit pulp respectively in three (3) communities; Agudama-Ekpetiama, Koro-ama and Yenegwe in Yenagoa Local Government Area of Basyelsa State , Nigeria.

Be that as it may, the following observations and recommendations were made: *Irvingia* spp., being high-valued indigenous multi-purpose trees, require government policies and regulations to prevent indiscriminate felling. Also their current wild growth necessitates domestication and cultivation of genetically engineered species to improve maintenance and boost fruit productivity. Further studies should explore their high industrial potential, and while this research focused on three communities, additional research should be conducted in other areas to determine the annual production of *Irvingia* fruit waste and individual consumption rates.

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