Knowledge-Based Assessment and training of Agricultural Development Programme (ADP) - Staff on Roselle as an economic valuable crop for food security and income generation.

Evaluación basada en el conocimiento y capacitación del Programa de Desarrollo Agrícola (ADP) - Personal sobre la jamaica como un cultivo económico valioso para la seguridad alimentaria y la generación de ingresos.

E.C. Omenna[*], O.T. Olanipekun, E.A. Ejigbo, E.O. Farinde, O.J. Adelakun, S.B.Fasoyiro, O.A. Ashaye

Agricultural Value Addition Programme, Institute of Agricultural Research and Training, Obafemi Awolowo University P. M. B. 5029, Moor Plantation, Ibadan, Nigeria

 *Corresponding email and Phone number: emmanuelomenna@gmail.com ; +2348055007555

ABSTRACT

The study was conducted to assess the knowledge of the Agricultural Development Programme (ADP)-staff on the nutraceutical and nutritional potentials of Roselle calyx as well as to train them on how to process the calyces for food sustainability and income generation. Pre-test and post-test evaluations were administered before and after the training respectively. The hand-on-training includes processing of different Roselle –products such as Roselle wine, Roselle tea, Roselle –Apple drink (RAD), Roselle-Sugar-drink (RSD)and Roselle Jam. Sensory evaluation was conducted on these Roselle food products using 9 –point hedonic scale (1=dislike extremely and 9=like extremely). Demographic survey showed that all the participants were females and about 75% were first degree holders while 25% were second degree holders. The results of pre-test showed that about 80% of the participants had been involved in previous training on other foods processing. Although, < 50 % of the participants had little or no knowledge about Roselle processing. Sensory evaluation showed that RSD was the most preferred sample by the panelists with a rating score of 8.4 point. On the same vein, the panelists' responses implied that RSD was significantly rated higher than RAD in terms of flavor, taste and texture. Other Roselle products like Roselle jam, wine and tea were sensorially rated high indicating general acceptability. In conclusion, the result of post- training evaluation showed that more than ninety percent of the participants were eager to put the acquired skills into practice and had expressed their readiness to generate income.

Keywords: Roselle calyx, Roselle jam, Apple-flavored drink, Roselle tea

RESUMEN

El estudio se realizó para evaluar el conocimiento del personal del Programa de Desarrollo Agrícola (ADP) sobre los potenciales nutracéuticos y nutricionales del cáliz de Roselle, así como para capacitarlos sobre cómo procesar los cálices para la sostenibilidad alimentaria y la generación de ingresos. Se administraron evaluaciones previas y posteriores a la prueba antes y después del entrenamiento, respectivamente. La capacitación práctica incluye el procesamiento de diferentes productos de Roselle como el vino de Roselle, el té de Roselle, la bebida de Roselle-Apple (RAD), la bebida de Roselle-Sugar-drink (RSD) y la mermelada de Roselle. La evaluación sensorial se llevó a cabo en estos productos alimenticios de Roselle utilizando una escala hedónica de 9 puntos (1 = me disgusta extremadamente y 9 = me gusta extremadamente). La encuesta demográfica mostró que todos los participantes eran mujeres y que alrededor del 75 % eran titulares de primer grado, mientras que el 25 % eran titulares de segundo grado. Los resultados de la prueba previa mostraron que alrededor del 80% de los participantes habían recibido capacitación previa sobre el procesamiento de otros alimentos. Aunque, <50% de los participantes tenían poco o ningún conocimiento sobre el procesamiento de Roselle. La evaluación sensorial mostró que RSD fue la muestra preferida por los panelistas con una calificación de 8,4 puntos. Del mismo modo, las respuestas de los panelistas implicaron que RSD obtuvo una calificación significativamente más alta que RAD en términos de sabor, sabor y textura. Otros productos de Roselle, como la mermelada de Roselle, el vino y el té, recibieron una calificación sensorial alta, lo que indica una aceptabilidad general. En conclusión, el resultado de la evaluación posterior a la capacitación mostró que más del noventa por ciento de los participantes estaban ansiosos por poner en práctica las habilidades adquiridas y expresaron su disposición a generar ingresos.

Palabras clave: Cáliz de Roselle, mermelada de Roselle, bebida con sabor a manzana, té de Roselle

INTRODUCTION

Roselle (*Hibiscus sabdarffa*) also known as sorrel is a herb belonging to the family of *Malvaceae*. Roselle is locally known by different names in different countries (Ismail *et al*., 2008). Roselle originated from West Africa and is widely grown in tropical African countries like Sudan, Egypt, Mali, Nigeria, Ethiopia, Chad as well as India, West Indonesia, Brazil, Malaysia, Australia, Mexico, the Philippines and other tropical American countries (Shoosh, 1993). But it is disheartening to note that the potentials of this miraculous crop (Roselle) is grossly underutilized in some developing countries likely Nigeria. Roselle remains one of the underexploited food crops with nutritional and food industry processing potentials. For instance, Roselle seed is a good source of oils for nutritional, pharmaceutical and purposes (Betiku and Adepoju, 2013; Anel *et al*., 2016). Several parts of roselle (*H. sabdariffa)* such as the flower and leaves are used as vegetables in many countries. Roselle calyx and leaves among others possess beneficial health characteristics for humans (Cid-Orteg and Guerrero-Beltran, 2016). Every part of Roselle plant including fruits, roots

and seeds is utilized in various foods. Furthermore Islam *et al.* (2016) reported that Roselle is more than an eye-catching crop and has been used in number of dishes, beverages and conventional remedy for diseases. And it follows that if the potential of Roselle is well-harnessed, Roselle is an economic crop for wealth creation. Roselle extracts are also used as natural pigments for foods and beverages as well as for preparing jams, ice-cream, gelatin, pudding, cakes, jellies and concentrates possessing red colour with a characteristic sour taste. Several research publications have pointed out that Roselle extracts may have various therapeutic effects; one of which emphasized on its antioxidant capacity, and this was attributed mainly to the content of anthocyanins and phenolic compounds (Tsai and Huang, 2004). Roselle calyces have a characteristic deep red colour, which is mainly due to the presence of anthocyanins. The most common use of Roselle calyces is for obtaining aromatic infusions of intense red colour that are traditionally consumed either cool or hot. (Tsai, *et al.*, 2002; Tsai and Huang, 2004; Anokwuru, *et al.*, 2011; Amer *et al.*, 2012). It has been reported higher antioxidant capacity in roselle calyces of red variety than in the white variety (Christian and Jackson, 2009). Roselle seed is a valuable food resources on the account of its protein, calorie, fat, fibre and micro-nutrients (Akanbi *et al.*, 2009). Roselle calyces contain nine times more vitamin C than C*itrus sinensis* (Amin *et al.,* 2008*).*There is great market potential for farmers of Roselle as a cash crop in Nigeria

 In view of the multi-farious nature of Roselle crop, the Institute of Agricultural Research and Training, (IAR&T) Ibadan, Nigeria has developed and processed different products such as Roselle jam, Roselle wine, Roselle tea, Roselle drink (zobo) among others from Roselle. Training package was organized for the- manpower trainers in agriculture and other food related processing industries. The processing and packaging technologies will not only increase income generation of middle and average household-mothers but also boost the nutrition security of their households. The major objective of this research work was to unveil the nutritional potential of Roselle as well as to empower the household-mothers with the requisite skills for processing Roselle foods for a sustainable livelihood. It is aimed at train the trainers on Roselle processing, food safety practices and adequate packaging as well as value-addition of Roselle products. This   will open new opportunities for income and employment generation in many developing countries like Nigeria. Without doubts, when Roselle –food-products are well packaged, it will contribute to the economic growth of the nation (Nigeria) in terms of gross domestic products (GDP) through export as a source of foreign exchange earnings.

MATERIALS AND METHODS

Selection of participants (women and youth) for the training

• Invitation of subject matter specialists from the Oyo State Agricultural Development Programme (ADP)

• Carry out pre-test evaluation on the participants' knowledge about the importance, uses and processing of Roselle

- Enlightenment of the participants on the nutritional and health importance of Roselle

- Training of participants on Roselle drinks, Roselle fruit-flavoured drinks, jam, tea and Roselle wine

- Administer sensory test on the products with the participants

- Conduct post-test evaluation on the participants after the training.

Preparation of the sample materials for the training: Roselle calyces were harvested at maturity from the experimental field of Kenaf and Jute Programme, Institute of Agricultural Research and Training Ibadan, Nigeria. Dried calyces were sorted out to remove dirt.

Pre-test: Evaluation for the trainees' knowledge: A pretest was conducted on the respondents, who were the staff of the Oyo State Agricultural Development Programme (OYADP) Ibadan, Nigeria. The content of the questionnaire includes information on the: age, work type, education status, previous training in food processing and products, previous training in Roselle processing, using previous training for income generation

Dissemination and practical demonstration of Roselle technologies: The processing technologies for the different Roselle products were demonstrated during the training organized for the trainers in Agriculture Development Programme. Twenty staff of the Oyo State Agricultural Development Programme (OYADP) were present as participants. They were trained on processing of Roselle wine, Roselle-Apple Drink (RAD), Roselle-Sugar Drink (RSD), Roselle tea and Roselle jam. The processing method for Roselle drink was conducted according to Fasoyiro e*t al*. (2005) as well as the processing method for Roselle jam and tea were done according to prescribed procedure by Ashaye and Adeleke (2009). The flow chart for processing Roselle-apple drink (RAD) and Roselle-sugar drink (RSD): For production of Roselle fruit-flavored e.g. apple, pineapple, orange etc. drinks.Processing of Roselle tea and jam.
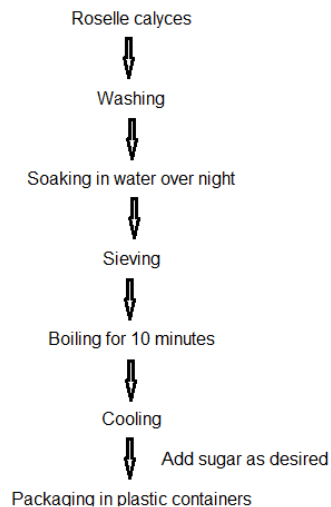

Figure 1: The flowchart for processing of Roselle drink

Wash the fruits

⬇

Peel and remove the core

⬇

Cut and blend with 1 cup of water

⬇

Sieve and pasteurize for 15 minutes

⬇

Add prepaed Roselle drink in ratio 7:3 cups

⬇

Add suggar if desired

⬇

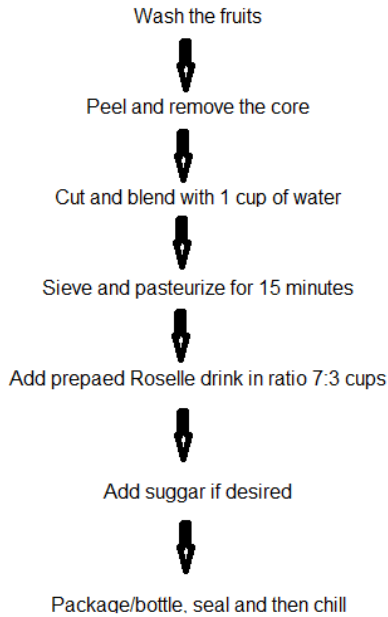Package/bottle, seal and then chill

Figure 2: The flowchart for processing Roselle fruit-flavored drinks

Processing of Roselle jam: The following steps were strictly followed while processing Roselle jam (Ashaye and Adeleke, 2009;Islam *et al*., 2016):

(a)   Collect and clean the fresh Roselle calyces

(b)   Boil the fresh calyces for 10- 15 minutes

(c)   Blend boiled calyces

(d)   Heat the blended calyces with sugar

(e)   Allow to cool

(f)   Cap and Preserve your Roselle jam in jars

   The following flow charts described the steps for Roselle tea and jam (Ashaye and Adeleke, 2009)

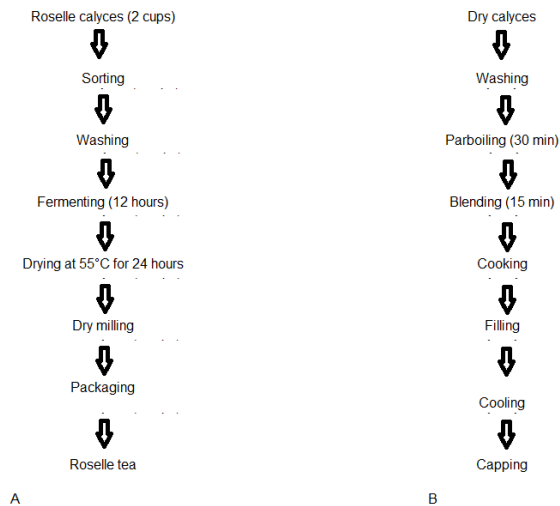| Roselle calyces (2 cups)	Dry calyces
⬇	⬇
Sorting	Washing
⬇	⬇
Washing	Parboiling (30 min)
⬇	⬇
Fermenting (12 hours)	Blending (15 min)
⬇	⬇
Drying at 55°C for 24 hours	Cooking
⬇	⬇
Dry milling	Filling
⬇	⬇
Packaging	Cooling
⬇	⬇
Roselle tea	Capping
A	B

Figure 3: Brewing of Roselle: (a) tea   (b) Roselle jam

Product development and Sensory Evaluation

Two categories of Roselle beverage drinks namely: Roselle –apple-drink (RAD) and Roselle –sugar- drink (RSD) were formulated and processed from Roselle extract and fruit juice pulp in the ratio 3:1 and 3:2 respectively for each product category. Roselle Jam was also processed as described by Islam *et al*. (2016). The developed Roselle products were randomly subjected to sensory evaluation as to determine the most preferred. This was done by a team of twenty (20) panelists who were the trainees for the products development. The products were presented as randomly coded samples. The products were analyzed for appearance, colour, flavor, texture, taste and overall acceptability. Each panelist recorded their degrees of likes and dislikes using a nine –point-hedonic scale (1= dislike extremely,   2 = "dislike very much", 3 = "dislike moderately", 4= "dislike slightly", 5= "neither like nor dislike", 6= "like slightly", 7= "like moderately", 8= "like very much"   and 9 = like extremely) as prescribed by Iwe (2003). Before each sample testing, the panelists rinsed their mouths with pure water as to avoid cross interaction of product sensorial properties.

Location: The training was conducted at the Institute of Agricultural Research and Training (IAR&T), Ibadan, Oyo State, Nigeria.

Target beneficiaries: The targeted beneficiaries of this training were the trainers in states' Agricultural Development Programme (who will in turn train farmers, youths, and women in agriculture).

Post-Test Evaluation: The participants were evaluated after the training on the following: understanding of food processing after the training, understanding of Roselle processing, mentioning Roselle-food products, ready to process of Roselle-food products for income generation.

Statistical Analysis: All data obtained were subjected to two ways Analysis of variance (ANOVA) and means were separated using t- Test with significant difference at $P < 0.05$

RESULTS AND DISCUSSION

Socio-demographic Characteristics of the participants: Twenty participants (all women) from the Oyo State Agricultural Development Programme (OYADP) were present at the training and the training was participatory. Post test showed that half of the participants were mainly in the age range 41-50 year ($\leq$ 50%) with education up to postgraduate level as 25% of the participants. All the participants had previous knowledge in food processing such as: cassava, plantain, fruits, soybean processing. Majority of the participants had previous training on other food processing while few number of participants had previously involved in Roselle drink (popularly called Zobo), but not in fruit-flavored drinks processing. Significant number of the participants have no previous knowledge in Roselle jam

and tea processing. The novelty in these Roselle food products underpinned the need to explore its potentials in food industry and this result was strongly supported the publication report by Leung and Foster (1996).

Although, less than twenty percent of the participants were able to mention four Roselle products before the training neither did any of the participants indicated their readiness generate income with their previous training. This may probably be due to inadequate on the processing technologies.

Sensory evaluation: Sensory analyses of the different formulations for RAD and RSD were presented in Table 3. From the result, it was observed that RSD was most preferred by the panelists with a rating score of 8.4 point. On the same vein, the panelists' responses showed that RSD was significantly rated higher than RAD in terms of flavor, taste and texture. This observation was in contrast with the data reported by Ismail et al.(2016) which highlighted that taste, aroma, consistency and flavor were not significantly different for ROD and RAD. This variation could be due to infinitesimal amount of fruit juice used was not significant enough to have influenced the flavor, taste and texture of the mixture. However the appearance of the RAD and RSD were both significant ($p < 0.05$) and this was in consonance with the general knowledge about a consumer's judgement on the colour of the product. Generally all the categories of Roselle products were acceptable to the consumers. The sensory data and consumer's responses obtained from this study were in strong agreement with the publication report by Luvanga (2014), which emphasized that there was no significant difference among Roselle drinks mixed with apple, orange and melon.

Roselle calyces as beverage, jam and tea: The use of Roselle calyces in the production of beverage is novel, cost effective and income generating for household mothers and youth. Industrially, this novelty can be the best option for soft drink production items of its availability and cost. Either fresh or dried calyces can be used to prepare drinks as shown Figure 1b.The drinks made of fresh fruits, juices, or extracts are commonly consumed as cheap beverage in many African countries like Nigeria. According to publication report by Fellow and Axtell (2014) which emphasized that dried calyces and readymade drinks are widely available in the groceries and health food stores throughout The United Kingdom and United States. However, ninety-eight percentage (98 %) of the participants who were staff of the state government,) expressed their readiness to use the new technologies for income generation. Preparation of Roselle tea was outlined in Figure1a. Roselle tea is commonly called sugary herbal tea in many African countries, while in Jamaica Roselle tea is produced by adding flavor from ginger. It was believed that Roselle tea reduces cholesterol level and was highly valued as organic product (Mohamed et al., 2012).

Roselle jam processing was described as the most effective and attractive way of utilizing Roselle. Jam is easy to make only with Roselle calyces and sugar. Roselle jam has been reported to be rich in vitamin B1, B2, B3 and C, minerals and antioxidants. These antioxidants are from calyces are good for our heart.

Multipurpose uses of roselle parts: Roselle is an underutilized multipurpose crop with enormous potentials for economic and industrial development aiming at food and nutrition security. The secondary nutritional data adopted from Islam et al.(2016) as shown in Table 4, it was evidence that every part of Roselle is nutritious and

posses great health benefits to humans.Due to roselle's nutritional benefits ,dietary inclusion of roselle based-products is imperative to achieve nutrition security. Consumption of Roselle based-products enriches the consumer with vitamin C,B, phosphorus, calcium, antioxidants and other mineral elements. Roselle products are affordable to poor, average, intermediate and rich class of people in the society (Dy Phon, 2000).

As conclusion, the sensory evaluation showed that all the Roselle products assessed: Roselle-Apple Drink (RAD), Roselle Sugar Drink (RSD) and Roselle jam were highly acceptable to the participants. Post test results showed that 100% of the participants had better understanding in food and Roselle processing after the training. All the participants (100%) also showed their readiness to explore the nutritional potentials of Roselle calyces for generation of income.

Plate a: Participants inspecting the calyces being sundried

Plate b: Cross section of the Participants at the training lecture

Plate c: Cross- section of the participants during the hands–on- training (Practical session)

Table 1: Demographic profile of the participants

Biodata of participants	Frequency	Percentage (%)
Sex	-	-
Male	-	-
Female	20	100
Age		
10-20	-	-
21-30	4	20
31-40	6	30
41-50	10	50
51-60	-	-
Work type		
Government	20	100
Unemployed	-	-
Student	-	-
Trader	-	-
Education		
Primary	-	-
Secondary	-	-
Tertiary/University	15	75
Postgraduate	5	25

Table 2: Pre-test on the participant's involvement on previous training in food processing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	16	80.0	80.0	80.0
	No	4	20.0	20.0	100.0
	Total	20	100.0	100.0	

if yes (on what)

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	15.8	15.8	15.8
cassava and sweet potato	1	5.3	5.3	21.1
orange fleshed and sweet potato	2	10.5	10.5	31.6
cassava products	2	10.5	10.5	42.1
processing of various food items	1	5.3	5.3	47.4
coco bite,cassava bread,cassava chin chin,kunu and soya milk	1	5.3	5.3	52.6
orange fleshed, sweet potato and cassava processing	1	5.3	5.3	57.9
yam chips	1	5.3	5.3	63.2
zobo juice	2	10.5	10.5	73.7
preparation of cocobite from vitamin A cassava flour, preparation of zobo, kunu and tapioca	1	5.3	5.3	78.9
cassava utilization	1	5.3	5.3	84.2
cassava, plantain, sweet potato utilization and pineapple into wine	1	5.3	5.3	89.5
soyabean and cassava	1	5.3	5.3	89.5
zobo drink and cocobite	2	10.5	10.5	100.0
Total	20	100.0	100.0	

Table 3: Mean sensory scores of Roselle products by the participants using 9-point hedonic scale

Product	Colour	appearance	Flavor	Texture	Taste	Overall acceptability
RAD	7.5	7.7	5.8	7.2	5.0	6.4
RSD	8.0	7.7	7.3	7.8	8.0	8.4
Roselle jam	8.0	8.0	7.0	7.0	8.0	7.0

Roselle tea	8.1	7.5	7.0	6.5	7.5	8.0

Table 4: Nutritional composition of 100g fresh Roselle calyces, leaves and seed

Constituents	Fresh Roselle calyces	Fresh Roselle leaves	Roselle Seed
Moisture	9.20g	85.60g	8.2g
Crude protein	1.15g	3.30g	19.60g
Crude fat	2.61g	0.30g	16.0g
Crude fibre	12.0g	10.00g	11.0g
Energy	44kcal	43kcal	411kcal
Ash	6.90g	1.00g	7.00g
Ca	12.63mg	213.00mg	356mg
P	273.20mg	93.00mg	462mg
Fe	8.98mg	4.80mg	4.20mg
Carotene	0.03mg	4135µg	-
Thiamine	0.12mg	0.2mg	0.1mg
Riboflavin	0.28mg	0.45mg	0.15mg
Niacin	3.77mg	1.2mg	1.4mg
Ascorbic acid	6.7mg	54.0mg	No trace
Carbohydrate	10.0g	9.2g	51.3g

Adopted from Islam *et al*. (2016)

Table 5: Participant's response to previous training on food processing

if yes (where)				
Organizer of training	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4	20.0	20.0	20.0
IAR&T and OYSADEP	2	10.0	10.0	30.0
OYSADEP	9	45.0	45.	75.0
IITA	1	5.0	5.0	80.0
IAR&T	2	10.0	10.0	90.0
OYSADEP AND IITA	2	10.0	5.0	100.0
Total	20	100.0	100.0	

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4	20.0	20.0	20.0
OYSADEP	6	30.0	30.0	50.0
OYSADEP(WIA)	3	15.0	15.0	65.0
WIA	1	5.0	5.0	70.0
OYSADEP(WIA) and IAR&T	1	5.0	5.0	75.0
USAID	1	5.0	5.0	80.0
IAR&T	2	10.0	10.0	90.0
OYSADEP, IAR&T, IITA, USAID and NIHORT	2	5.0	5.0	100.0
Total	20	100.0	100.0	

Previous training in Roselle processing				
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	13	65.0	65.0	65.0
	No	7	35.0	35.0	100.0
	Total	20	100.0	100.0	

if yes (on what)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		9	45.0	45.0	45.0
	Roselle	2	10.0	10.0	55.0
	zobo drink	7	35.0	35.0	90.0
	Drink	2	10.0	10.0	100.0
	Total	20	100.0	100.0	

if yes (where)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		7	36.8	36.8	36.8
	OYSADEP	11	57.9	57.9	94.7
	OYSADEP and NIHORT	1	5.3	5.3	100.0
	Total	19	100.0	100.0	

Trainer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		6	30.0	30.0	30.0
	OYSADEP(WIA)	8	40.0	40.0	70.0
	WIA	2	10.0	10.0	80.0
	OYSADEP	4	20.0	20.0	100.0
	Total	19	100.0	100.0	

Table 6: Mention Roselle products you know

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		4	20.0	20.0	20.0
	?	1	5.0	5.0	25.0
	zobo drink	5	25.0	25.0	50.0
	zobo and isapa stew	2	10.0	10.0	60.0
	drink and soup	1	5.0	5.0	65.0
	zobo drink and soup	2	10.0	10.0	75.0
	zobo ginger drink	2	10.0	5.0	80.0
	roselle drink	3	15.0	15.0	100.0

Total		20	100.0	100.0

from your previous training, are you generating income?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		2	10.0	10.0	10.0
	Yes	8	40.0	40.0	40.0
	No	10	50.0	50.0	50.0
	Total	20	100.0	100.0	100.0

Table 7: Trainee 's understanding about food processing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	20	100.0	100.0	100.0

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	20	100.0	100.0	100.0

Table 8: Roselle products that the trainee can process

	Frequency	Percent	Valid Percent	Cumulative Percent
Roselle wine, Roselle drink and Roselle jam	3	15.0	15.0	15.0
Roselle wine, Roselle drink, Roselle jam and Roselle tea	12	60.0	60.0	75.0
Roselle drink, Roselle jam and Roselle tea	2	10.0	10.0	85.0
Roselle wine, Roselle drink with apple, Roselle jam and Roselle drink with sugar	3	15.0	15.0	100.0
Total	20	100.0	100.0	

Table 9: Is the trainee ready to generate income from these products

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	20	100.0	100.0	100.0

Table 10: Pre-test information

	Number	Percentage (%)
Previous training in food processing	20	100
Previous training in roselle processing	15	75
Able to mention roselle products		
One	20	-
Two	-	-
Three	-	-
Income generation from previous training	7	35

Table 11: Post-test information

	Number	Percentage (%)
Better understanding in food processing	20	100
Better understanding in Roselle processing	20	100
Able to mention Roselle products		
Only One product		
Only Two products	-	-
Only three products	-	-
Four products	2	10
	18	90

Processing for income generation	20	100

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