The Utilization and Preservation Practices of Jute Mallow (*Corchorus olitorius*) In Western Kenya.

ABSTRACT

Background: Jute mallow (*Corchorus olitorius*) is a nutritious African leafy vegetable that is grown and consumed by local communities in Kenya. However, despite its nutritional superiority, its utilization is limited primarily due to its seasonality.
Aim: This study sought to document the utilization and preservation practices of jute mallow in Western Kenya.
Methodology: A cross-sectional study, that involved a household survey (n =139), of jute mallow producers in Kakamega County of Western Kenya, was conducted.
Results: Half (50.4%) of the households sourced their vegetables from their farms, while 37.4% sourced them from roadside vendors during the dry season. Jute mallow was mainly (57.6%) consumed as an accompaniment with other vegetables including African Nightshade and Amaranth. Approximately half (52.51%) of the households, employed a method of preservation. There was a significant association ($p = 0.01$) between age and preservation practices, where middle-aged people (35-50 years) had a higher likelihood of employing a preservation method. Women were also significantly ($p = 0.024$) more likely to preserve vegetables than men. Sun drying was practiced by 15.8% of the study population,18.7% practiced fermentation, while 18% practiced both fermentation and sun-drying. The methods of sun-drying were well developed, where prior blanching, was incorporated by 33.3% of the participants. Sun-drying extended the shelf-life of jute mallow by 4.02 ± 3.151 months, while fermentation was 7 days. The leaves of both forms of preservation had relatively high acceptability ratios to the fresh forms at 40% and 48% for fermented and dried forms, respectively.
Conclusion: There is a huge potential for low-cost preservation methods in ensuring the availability of jute mallow. However, it is necessary to investigate the viability of these methods on the nutritional quality and safety of jute mallow to improve food security.

Keywords: Jute mallow, Postharvest handling, Preservation practices, Food Security, Sun-drying, Fermentation

1. INTRODUCTION

Jute mallow *(Corchorus olitorius)* belongs to the family *Tiliaceae* and is of significant value in the rural parts of Kenya [1]. Like many African leafy vegetables including amaranth (*Amaranthus spp),* spider plant (*Cleome gynadra*), and African nightshade (*Solanum spp),* jute mallow has been, in the past, referred to as a weed and wildly growing plant [2].

However, these vegetables have recently been domesticated and are now commercially available, although grown on a small scale.

Jute mallow has been identified as one of the key African leafy vegetables that have a role in biodiversity and food security in sub-Saharan Africa promoted due to its nutritional superiority [3]. Annual global production of Jute mallow in 2018 was 9.93 billion tonnes, where Africa contributed 29.4% of its production asserting the promising future of the crop [4]. In Kenya, jute mallow has gained particular acceptance in Western Kenya, where the local communities have adequately developed methods of preparing various cuisines from it [5]. The total annual production of jute mallow in Kenya increased by 15.26% between 2015-2016 [6]. Utilization of the leaves provides micronutrients such as vitamin C, beta-carotene, iron, and zinc, whose inadequacies contribute to hidden hunger in the region [7]. The vegetable is also rich in micronutrients, anti-inflammatory, and anti-tumor properties [8]. Therefore, consumption of African leafy vegetables including jute mallow, not only promotes nutrition and health but is also a possible avenue for income generate in Kenya [3].

Despite the knowledge of its nutritional vitality, the utilization of jute mallow in Kenya is still sub-optimal. Its consideration as a minor crop has limited its inclusion in research and developmental programs [9]. Notably, the production of jute mallow is usually seasonal where it grows profusely during the rainy season. However, due to its high perishable nature, its supply reduces significantly during the dry season [2]. Consequently, the local communities have developed various low-cost post-harvest handling and preservation practices, primarily sun-drying and fermentation [10]. However, the scope of the techniques and their possible effect on the nutritional quality and safety of the product has not been ascertained nor documented. Therefore, this study sought to avail this information to identify and replicate the good practices to promote the year-round availability of jute mallow, in order to contribute to food security.

2. METHODOLOGY

2.1 Study Design

A cross-sectional study design involving observational methods was used in this study. Randomly selected households in Kakamega County involved in the production of jute mallow were included in the study. A semi-structured questionnaire was administered to the participants during the survey

2.2 Study Setting

The study was conducted in Kakamega County, which is situated in the western part of Kenya. It is bordered by five counties, namely, Bungoma County, Nandi County, Vihiga County, Siaya County, and Busia County, as shown in Figure 1. In total, the County covers about 3224km^2, with a population of about 1,660,651. The County has an annual population growth rate of about 2.12%. The capital of the town is Kakamega Town. The County is divided into twelve sub-counties namely, Malava, Lugari, Lurambi and Shinyalu, Likuyani Navakholo, Matungu, and Butere, Mumias West, Khwisero, Ikolomani, and Mumias East which are further divided into 60 electoral wards. The County experiences an average temperature of about 20.5^{o}C. The main economic activities are agricultural activities and informal businesses. Rainfall received in the County is between 1,250 – 1,750 mm per annum. Likuyani County, which is the main focus of this study, has a population of 125,137 and has been divided into five wards, namely; Likuyani, Sango, Kongoni, Nzoia, and Sinoko [11].

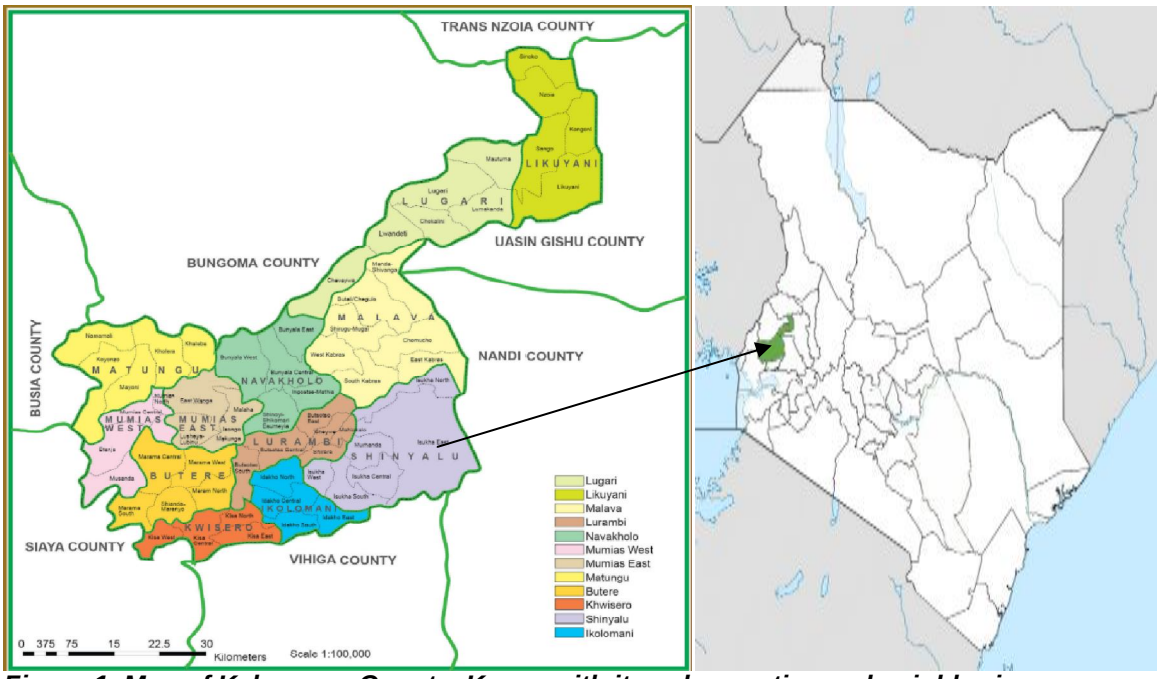


***Figure 1: Map of Kakamega County, Kenya with its sub-counties and neighboring counties* [11].**

2.3 Sample Size Calculation

Fisher et al (1998) sample size calculation formula was used in the determination of the number of participants in the survey.

Therefore;

$$n = \frac{Z^2 pq}{d^2}$$

Where:

n = Desired sample Size [where population > 10,000]

Z = The desired confidence interval, taken at 95%

Z value at 95% is 1.96

p = Proportion of the population who process jute mallow leaves is 0.9 [16]

q = Proportion of the population who do not process jute mallow leaves is 0.1

d = Degree of precision; was taken to be 5 %, which is 0.05

$$n = \frac{1.96 \times 1.96(0.9 \times 0.1)}{(0.05)(0.05)} = 138.29$$

one (1) participant was added to cater to attrition

Therefore, 139 households were interviewed

2.4 Sampling Technique

Kakamega County was purposively sampled from Kenya due to the high production and consumption of jute mallow in this area. Likuyani Sub-County within Kakamega county was also purposively sampled from the country due to the high production of jute mallow. Sinoko, Nzoia, and Kongoni wards within the Likuyani sub-county were purposively selected in this study. The sample of 139 households was randomly selected across the three wards. A single respondent was drawn from each household.

2.5 Data Collection Tools and Methods

A semi-structured questionnaire was used to collect data on the respondent's biodata. The questionnaire captured information on demographic characteristics, sourcing, utilization, and

preservation techniques of jute mallow. The demographic characteristics included age, sex, marital status, relationship to the household, and education level. The questionnaire was administered to the selected respondents during the interview period. Before the interview, the respondents were asked to provide their consent and asked to participate in the study voluntarily. Those who could read and write filled out the questionnaire on their own. At the same time, those who were unable were interviewed by well-trained enumerators. Enumerators translated the questions and filled the responses that were provided by the respondents.

2.6 Statistical Analysis

Data collected from the field survey were coded and entered into SPSS IBM version 23 and analyzed. Descriptive statistics namely, percentage and frequency were used to express the results of the socio-demographic characteristics of the study population, utilization of jute mallow, and different preservation techniques. A chi-square test of significance was used to test for any existing significant associations between the various variables studied with $p = 0.05$ set as the level of significance.

3. RESULTS AND DISCUSSION

3.1 Socio-economic and Demographic Characteristics of the Households

The socio-demographic characteristics of included households are shown in Table 1. In this study, more than half (54%) of the household respondents were women. The majority of the household respondents (44.6%) were aged between 18-35 years, while the age group above 65 years had the least percentage of participants (3.6%). Age was an important demographic factor that helped the researcher determine which age groups took part in the farming and preservation of jute mallow. The largest percentage (41.7%) of household respondents had attained primary level education, while 28.8% of the population had attained secondary education. This data compares with that from the Kenya Demographic and Health Survey (KDHS), which reported that 55.2% of the population in Western Kenya had received some primary level education while 15.8% had attained secondary level education [12].

Most of the households were farmers by occupation (27.3%). The majority of the households (89.9%) agreed that women decided on the food to be bought for the family. This is because women are more involved in the cooking and preservation of food than men. Culturally, the role of food production and preparation is assigned to women [13]. This signifies the cultural role of women as the principal guarantors of nutrition, food safety, and quality at the household level [14].

Table 1: Socio-economic and demographic characteristics of Jute mallow-producing households in Kakamega County

Characteristics	Percentage (%)
Gender	
Female	54
Male	46
Age	
18-35	44.6
35-50	34.5
50-65	17.3
>65	3.6
Education Level	
Completed Primary	41.7
Completed Secondary	28.8
University	15.8
Never went to school	7.2

Tertiary	5.8
In Secondary	0.7
Marital Status	
Married	68.3
Unmarried	31.7
Occupation	
Farmer	27.3
Trading	23.7
Salaried Employment	20.1
Casual labor	11.5
Student	10.1
Unemployed	7.2
Who decides on Food to be bought	
Mother	51.8
Wife	38.1
Any other	5.8
Father	2.2
Husband	2.2

3.2. Sourcing and Utilization of Jute Mallow Leaves

Half (50.4%) of the households sourced jute mallow mainly from farms, where it grew freely as a weed as displayed in (Figure 2). Additionally, jute mallow was also sourced from roadside vegetable vendors and the market, especially during the dry season when it becomes scarce on the farms. Similarly, it has been reported that jute mallow is easily accessible from the local markets and at the household farm level in Western Kenya [15].

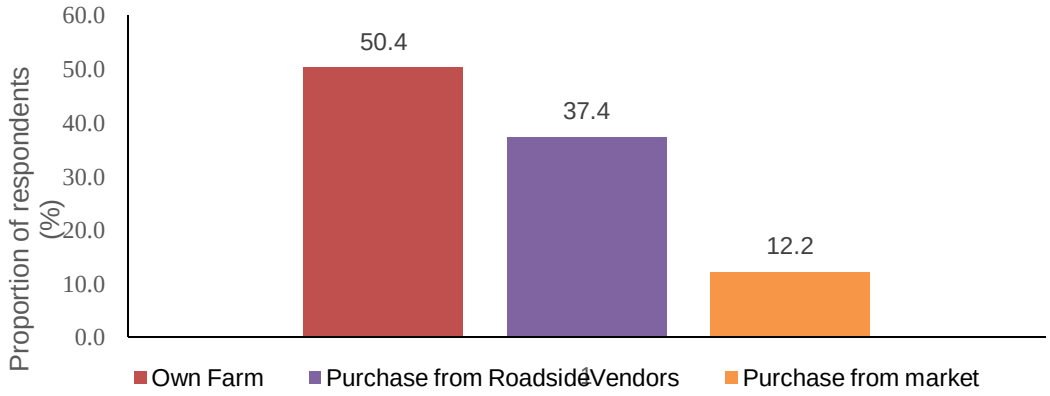


Figure 2: Sourcing of Jute Mallow Vegetables by Producing Households

The majority of the households (57.6%) reported incorporating jute mallow in the diet as a composite with other vegetables. Jute mallow was also consumed singly (26%) as a vegetable and mashed (16.4%) with other foods. As a composite, jute mallow was mixed with cowpea leaves (62.6%), and slender leaves (28.1%). This observation is in line with [16] who reported that jute mallow is blended with other local vegetables such as *Solanum nigrum, Crotalaria brevidens, Cleome gynandra,* and *Amaranthus spp*. The frequency of jute mallow consumption was 2.31± 0.82 days a week, with the whole family (69.8%) as the primary consumers although some respondents reported that the vegetable was mostly consumed by pregnant women and breastfeeding mothers. These findings are similar to those reported by Gido [16] where jute mallow is common amongst expectant and breastfeeding mothers since it is believed to stimulate the production of milk during the

lactation period. Jute mallow was also reported to have medicinal uses by half (56.1%) of the respondents, mainly for treating constipation and anemia. Ali [17] reported the jute mallow in ethnobotanical medicine, where the leaves are used to treat ailments such as headache, influenza, fever, and pectoral pains as well as contains anti-inflammatory, gastroprotective, wound-healing, antiseptic, and anticancer properties. The by-products of jute mallow, more especially the stems, are used to feed chicken or livestock [18].

3.3 Preservation Practices of Jute Mallow in Producing Households

Half (52.51%) of the households in this study employed a method of preservation of jute mallow. The chi-square test indicated that age, gender, and occupation influenced the preservation technique as displayed in Table 2. Out of those who carried out preservation, 63% were women and 37% were men. According to Manuche [24] women are responsible for feeding the family and hence see the need to have vegetables during the dry season, which may account for the higher percentage. In this study, the preservation of vegetables was significantly associated with age (χ^2 = 17.250, p = 0.01) as displayed in Table 2. Household respondents over the age of 35 years tended to preserve vegetables more than the younger respondents. While Ayua & Omware [10] stipulated that the art of preservation of vegetables in Western Kenya is passed down to younger generations. This current study reveals that this knowledge is no longer being passed down and that with time traditional methods of preservation might cease. There was a significant association between the occupation and preservation of jute mallow (χ^2 = 19.212, p = 0.002). Farmers made up the largest group of people who preserved jute mallow. This may be due to their easy access to jute mallow, especially during the rainy season [10].

Table 2: Association between preservation practices and socio-economic and demographic characteristics in jute mallow processing households

Socio-economic and Demographic factors		Households practicing preservation (%) n=139	Households not practicing preservation (%) (n=139)	*P*-value
Occupation	Farmer	20.9	79.1	
	Salaried	11.5	88.5	0.002
	Employment informal	10.8	89.2	
	Businesses			
	Casual labor	4.3	95.7	
	Unemployed	3.6	96.4	
	Student	1.4	98.6	
Gender	Female	63.0	37.0	
	Male	37.0	63.0	0.024
Age	18-35	15.82	84.18	
	50-65	12.94	87.06	
	35-50	20.14	79.86	0.01
	>65	3.5	96.5	
Level of Education	Primary	23.74	76.53	
	Secondary	16.52	83.48	
	Never went to School	5.755	94.245	0.067

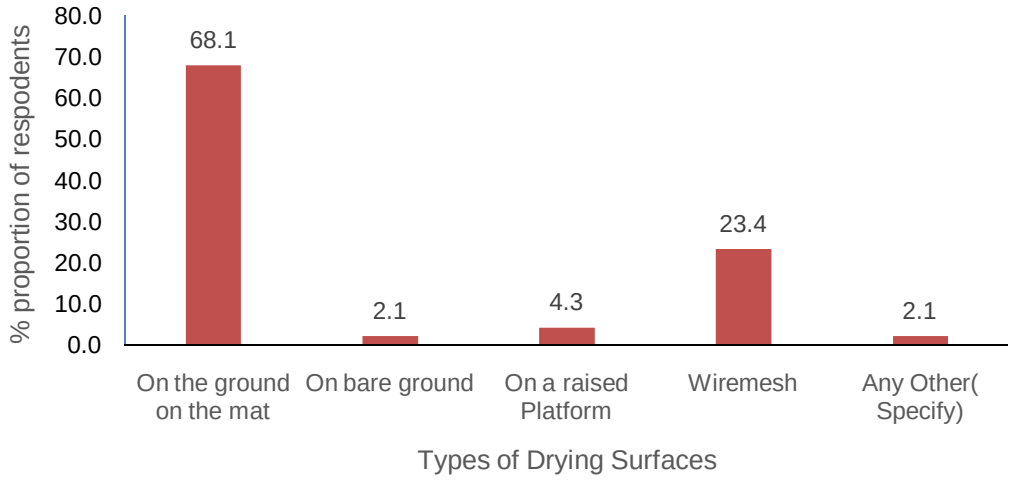
	University	4.32	95.68	
	Tertiary	2.8	97.2	
Name of the Ward	Nzoia	19.42	80.58	0.93
	Sinoko	17.26	82.74	
	Kongoni	15.8	84.2	

4.1.4 Distribution of Households by the Methods of Preserving Jute Mallow Processing Households

Out of the 139 households in this study, 15.8% practiced sun-drying exclusively, 18.7% fermentation, and 18% practiced both fermentation and sun drying. The techniques used for drying vegetables varied among the households. A majority (57.7%) of those who practiced sun-drying reported simply sorting and drying jute mallow. Blanching was practiced by 33.3% while washing the vegetables before drying was practiced by 42.2% of those who practiced sun drying. Blanching was conducted by boiling the water for an average of 20 ± 0.234 minutes, after which the leaves were drained of water and left to dry.

Washing helps in the reduction of dirt in the vegetables before drying, while blanching reduces the number of microorganisms present on the leaves and fixes the color of the vegetables prior to drying [19]. Shade drying was practiced by about 62.2% of the households, where the vegetables were placed under a shade during the drying process while the rest of the respondents dried the vegetables under direct sunlight. Shade drying allows for better retention of nutrients and minerals, such as vitamin C and iron which are easily degraded by solar energy [20]. On the other hand, direct sun drying reduces the amount of time required for drying vegetables [21].

Sixty-eight percent (68.1%) of the households reported placing the vegetables on the ground on a mat to allow them to dry (Figure 3). Other households used a raised platform and wire mesh structure to dry the vegetables. On average, the vegetables were dried 10.60 ± 0. 682 hours after being harvested. The facilities used for drying largely affect the quality and safety of the end product [22]. Placing the vegetables on a mat or wire mesh minimizes



contamination from the soil that may occur during drying [22].

Figure 3: Types of drying surfaces in the study households

3.4. Storage of Dried Jute Mallow in the Study Households

The dried jute mallow was stored differently in different households (Figure 4). The majority of the households (80%) placed the dried product in gunny bags, which were stored in a granary together with other food products such as maize and beans. However, other households reported storing the vegetables in kraft paper, and clean plastic buckets while others placed them on an open mat. Since the majority used gunny bags, there is a likely occurrence of deterioration of product quality during storage as a result of rewetting of the product which might make the product susceptible to mold contamination [23].

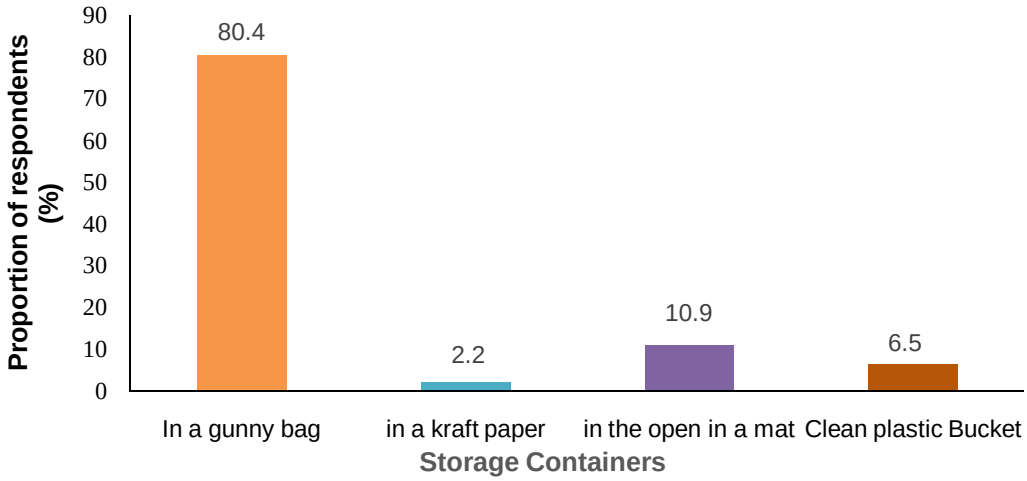


Figure 4: Types of storage containers of dried jute mallow in study households

The average period of storage of the dried jute mallow vegetables by the households was a period of 4.02 ± 3.151 months. This result is in line with that of Manuche [24] who reported that dried vegetables in Western Kenya were stored for an average period of three months. Usually, this period covers the dry season until the next rains [24]. During cooking, the dried vegetables are reconstituted by placing them in cold water for an average period of 26.90 ± 2.09 minutes. The water is then drained, and the vegetables are cooked in the same manner as cooking fresh vegetables. About 48% of the households reported that they would readily consume dried jute mallow as they would the fresh one, indicating the relatively high acceptability ratios of the dried product.

3.5 Traditional Fermentation by the Study Households

Traditionally, fermentation of jute mallow in the study households took place by following steps; the jute mallow leaves were boiled in water for an average period of 21.09 ± 0.345 minutes. The water is drained and then replaced with milk, which is added until the vegetables are soaked. The pot is then covered and stored in a dark place. The product is considered fermented after a period of two to three days. However, the process can go on for seven days. If further storage of the product is desired, the vegetables should be stored in a cool place, such as stored in an earthen pot or by refrigeration where applicable. The end product has a milky-like flavor. Before serving, the fermented product is usually sautéed with onions and tomatoes. Traditionally, the fermentation vessel was an earthen pot, however, currently, a stainless-steel pot (*sufuria*) is used. About 40% of the households consumed fermented jute mallow as they would the fresh one, indicating high acceptability of the product within the community, indicating the art of fermentation is practiced to improve the flavor and extend the shelf-life of jute mallow.

Several studies have recorded the traditional fermentation of African leafy vegetables. Manuche [24] reports that the black nightshade is fermented in Western Kenya by boiling the vegetable in water for about thirty minutes. The water is then replaced by milk, which is then boiled again for a shorter time. The product is then compressed and left to ferment for a few days until it solidifies till the color turns darker. The vegetable is then served with a starchy paste (*ugali)* [25]. A fermentation-like process for African kale that involves soaking the vegetables in milk to get rid of the bitter taste has also been reported [26].

4. CONCLUSION

Jute mallow is an important crop that has gained acceptance in Kenya, especially in Western counties. However, its utilization has been limited by the seasonality of the crop. Local communities have adopted low-cost methods to extend its shelf-life boosting its year-long availability. While the main methods of preservation; fermentation and sun drying have relatively high acceptability compared to the fresh forms, there is a need to investigate the effect preservation techniques have on the nutritional quality and safety of jute mallow. This would allow the scaling and transference of these methods to other vegetables to improve food security in Kenya.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between both authors. Author J.N. Muita designed the study, performed the analysis, and wrote the first draft of the manuscript. Author D.W.M Kaindi supervised the study and revised the manuscript. Both authors managed the literature search and writing of the final manuscript. The author wishes to thank the late Prof. J.K.imungi who designed and also supervised the study.

Consent

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

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