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RESEARCH ARTICLE

Consumption of Sweet-potato Leaves Vegetable and its Contribution to Iron Intake Among Women of Reproductive Age in Bomet County, Kenya

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ABSTRACT

Women of reproductive age (WRA) are particularly vulnerable to iron deficiency due to increased physiological demands. This 12-week quasi-experimental study introduced sweet-potato leaves, an underutilized, iron-rich vegetable, into the diets of WRA in a community where the vegetable had not previously been consumed. The aim was to assess changes in consumption habits and the contribution of sweet-potato leaves to overall dietary iron intake. A total of 118 WRA were selected through random sampling. A pre- and post-test design was used, with baseline data serving as the control. Data collection tools included semi-structured questionnaires and 24-hour dietary recall interviews administered at baseline, and at the 4th, 8th, and 12th weeks. Nutrient intake was analyzed using the NutriSurvey for Windows software. At the start of the study, sweet-potato leaves did not contribute to iron intake. By the end of the intervention, they accounted for 46% of total dietary iron intake. The mean iron intake increased significantly from 12.39 mg/day at baseline to 19.82 mg/day after 12 weeks (p=0.000). Additionally, the proportion of women meeting the recommended daily allowance for iron rose sharply from 8.5% to 86.4%. These findings demonstrate that incorporating sweet-potato leaves into daily meals can significantly enhance dietary iron intake among WRA. The study provides empirical evidence supporting the promotion of locally available, underutilized vegetables as sustainable dietary interventions to combat micronutrient deficiencies. Encouraging the consumption of iron-rich foods like sweet-potato leaves could be an effective strategy to address iron deficiency anaemia, contributing to better nutritional status and overall health outcomes for women of reproductive age.

Keywords: Diet, intake, intervention, iron, Sweet-potato leaves, women of reproductive age

INTRODUCTION

Iron is an important micronutrient that forms hemoglobin, a protein found in red blood cells whose primary role is to transport oxygen from the lungs to body tissues for the maintenance of basic body functions (Singh et al., 2024). Women of reproductive age (WRA) are vulnerable to insufficient iron intake that led to iron deficiency anaemia (IDA) (Owais et al., 2021). Anaemia affects about a half a billion WRA globally (World Health Organization, 2014). World Health Organization (2014) defines WRA to be those between 15-49 years. While women have higher needs for iron, they experience low intake due to various factors that include blood loss during their monthly menstruation cycle, increased blood demand during pregnancy and lactation periods. Non-pregnant WRA require about 18 mg/day of iron intake while pregnant women require an additional amount of 1.6 mg/day (FAO & WHO, 2001). Iron deficiency (ID) causes poor concentration, poor work performance, hair loss, ridged/brittle nails, depression, increased susceptibility to infections and greater risk of death (Benson et al., 2021). Furthermore, women who suffer from ID during pregnancy are at greater risk of giving birth to babies with low birth weights, having pre-term births, as well as perinatal and neonatal mortalities (Gautam et al., 2019). Anaemia is described as haemoglobin levels below 12 mg/dL for non-pregnant WRA and less than 11 mg/dL for pregnant WRA. Amounts between 8.0-11.9 mg/dL are considered moderate, while those below 8.0 mg/dL are severe. Iron can be consumed as heme or non-heme iron. Heme iron (from animal sources) has a high bioavailability of about 25% iron as compared to non-heme iron (from plant sources) which has a lower and highly variable bioavailability of between 0 and 20% depending on other factors that can either inhibit or enhance its absorption (Rodriguez-Ramiro et al., 2019). Nonetheless, animal-based foods are expensive and, in most cases, unaffordable to WRA from resource poor communities, hence their reliance on plant-based food as their main source of iron.

Various initiatives have been implemented globally and also in Kenya to address IDA. The efforts to alleviate IDA in Kenya have focused mainly on provision of iron supplements and fortification of foods with iron, which are short-term solutions. Iron-folic acid supplements (IFAS) is currently used as a high-impact, short-term nutrition intervention to specifically control anaemia in pregnancy (Kamau et al., 2020). Iron supplementation is commonly prescribed for individuals with low iron levels. Supplementation is a short-term approach since once the iron levels are restored, the prescription is stopped. Moreover, excessive intake of iron supplements can lead to toxicity, a precursor to other serious health issues (Kontoghiorghes, 2023). Conversely, in Kenya, fortification of maize and wheat flours with iron could mitigating ID (Garcia-Casal et al., 2018). However, most of these fortified flours are beyond the reach of resource poor households, who constitute about 70% of the entire population, that purchase flour or grind grain at the medium to small scale mills which have limited capacity to fortify flours (Aura, 2022). This situation highlights urgent need for a long-term approach to sustain iron levels efficiently.

Considering these challenges, food-based interventions are recommended as sustainable long-term alternatives for improving iron intake especially among communities with limited resources. Studies to support food-based interventions as reliable and sustainable alternatives have been conducted. Consumption of bio-fortified foods such as pearl millet by school children in India and iron bio-fortified beans by WRA in Rwanda (Finkelstein et al., 2019; Haas et al., 2016) improved the iron status of respondents in experimental studies. Similarly, biscuits that were bio-fortified with iron improved the iron status of school-going children in India (Bal et al., 2015). It is therefore evident that intake of iron-rich foods contributes to increased iron levels, particularly among households in low resource settings (Cercamondi et al., 2014). Given this, sweet-potato leaves, which are also rich in iron, could serve as an effective food-based strategy to mitigate ID. Building on this, in 2011, the Kenya Agricultural Research Institute (KARI) conducted breeding work to develop five new sweet-potato varieties (Kenspot 1-5).The sweet-potato varieties were introduced as a staple food in Bomet County in 2013 to help mitigate food insecurity (Karanja & Malinga, 2017). The initiative was aimed at countering maize production losses caused by MLND (Wangai et al., 2012), with the focus on using sweet-potato roots for human. The leaves were fed to livestock or discarded after harvest of the roots. The sweet-potato leaves have the five Kenspot sweet-potato varieties have been analysed for iron. Kenspot 2 has the highest iron content of 12.95 mg/100g dry matter when fresh and raw (Cheboswony et al., In press).

Sweet-potato grows well in the community of the study, is rich in Iron and therefore can be used as a long-term strategy to combat ID. The crop is adaptable to the study area since it is a drought tolerant crop that is easily propagated and is resistant to pests and diseases. In addition, utilization of sweet-potato in the study area has only been on the roots and yet sweet-potato leaves are rich in iron among other nutrients. Sweet-potato leaves are rich source of iron and if consumed could combat ID. Since ID is common in the region, the integration of sweet-potato leaves into dietary practices could provide a critical source of non-heme iron. Despite iron being less readily absorbed in non-heme iron compared to iron from animal sources, it is still an available and affordable source of iron for improving iron intake for vulnerable groups. Consumption of sweet-potato leaves vegetable is not well practiced in most parts of Kenya except the Western and Coastal regions. There has not been enough evidence from research on impact of introducing sweet-potato leaves vegetable on iron intake among a vulnerable group such as WRA. This study was part of an intervention study that introduced consumption of sweet-potato leaves as a vegetable and assessed its contribution to the health of WRA. Within the community that this study was carried out, sweet-potato leaves as a vegetable was not consumed completely by the women before the intervention study.

Considering this, the study area presented a unique opportunity of introducing sweet-potato leaves as a vegetable. The continuous search for crops that are adaptable to specific climatic conditions and that can combat specific deficiencies among a vulnerable group in an area is essential for cost reduction strategies and improving the overall health among individuals. Since sweet-potato had been introduced in the area, consumption of the leaves as a vegetable could aid mitigate ID among vulnerable groups such as WRA. The objective of this intervention study therefore, was to evaluate the incorporation of sweet-potato leaves into the diets of WRA. It aimed to assess the changes in their iron intake before and after the intervention. Additionally, the study investigated how the consumption patterns of WRA improved iron intake through the use of sweet-potato leaves.

METHODOLOGY

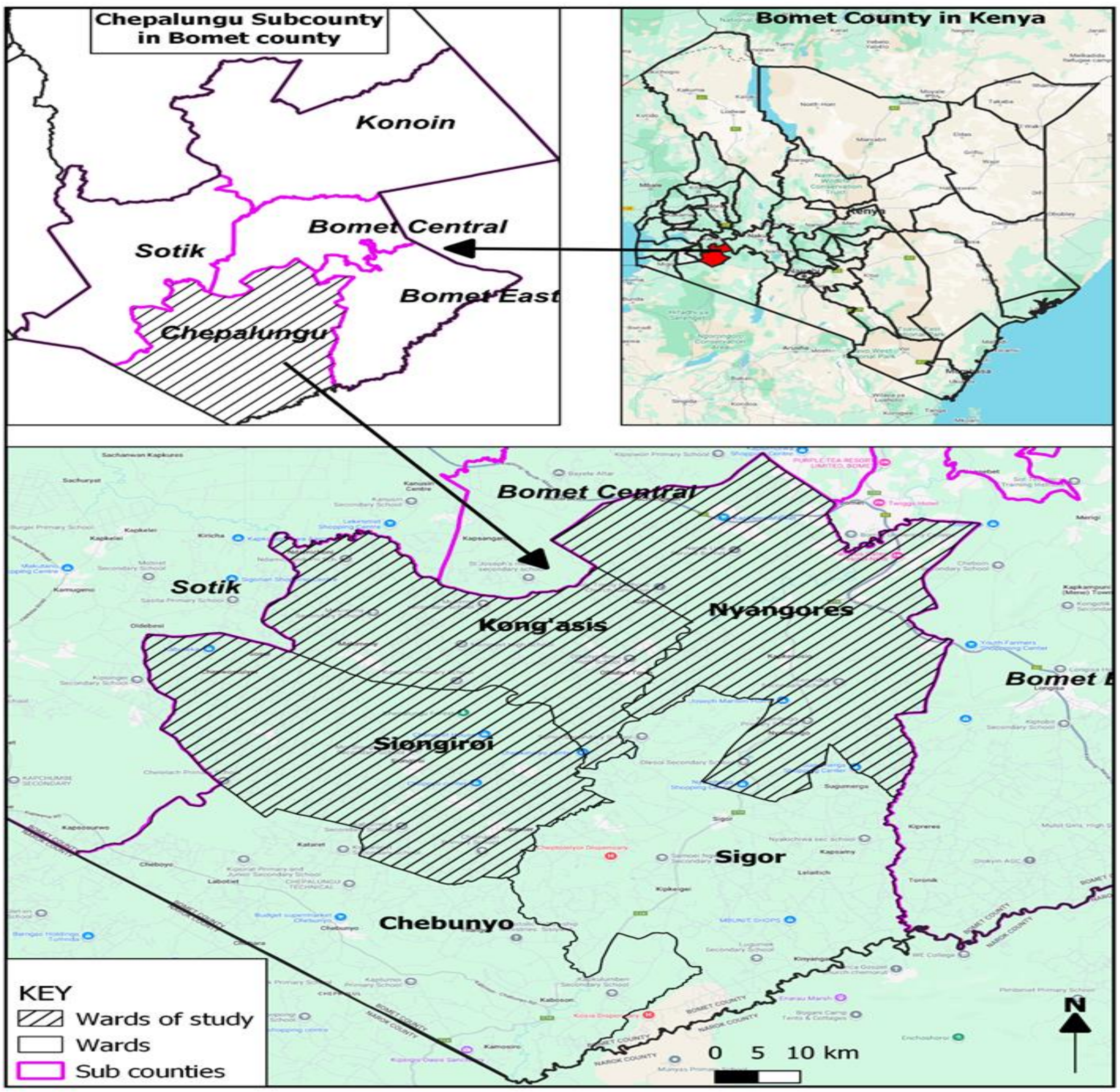
Study Design

The study was an intervention that adopted a single-group pre-test post-test research design. The study included a baseline survey, pre-intervention period, intervention study (consumption of sweet-potato vegetable leaves for 12 weeks), and an end-line survey. The baseline measurements served as a control to assess changes over time within the same respondents.

Study Location

Bomet County and Chepalungu Sub-County, Kenya, were purposively selected because sweet-potato had been introduced in the area in the year 2013 to promote root consumption as a food security crop. However, the consumption of sweet-potato leaves by household members was not introduced at that time. Chepalungu Sub-County comprises five wards: Siongiroi, Kong'asis, Nyongores, Sigor, and Chebunyo. For this study, Siongiroi, Kong'asis, and Nyongores Wards were purposively chosen because no other sweet-potato projects were ongoing there at the time. Figure 1 is the map of the study area.

Figure 1:
Map Showing the Study Area



Study Population

The target population for the intervention study were WRA between 18-49 years living within the study area. According to the WHO (2024), WRA are defined as being between 15 and 49 years old. However, due to ethical considerations regarding informed consent, this study only included women aged 18 years and above, ensuring that all participants could independently consent to their involvement in the study.

Sample Size

The sample size was calculated according to the formulae given by Gibson and Ferguson (1999) and Jekel et al. (2007), giving a sample size of 96 respondents. An attrition of 56% of the calculated sample size was included because a totally new food (sweet-potato leaves vegetable) was being introduced to the study respondents who were expected to consume the sweet-potato leaves vegetable for 12 weeks and a large percentage of drop-out was anticipated.

Sampling Frame

A sampling frame was developed with the help of ward administrators, chiefs, assistant chiefs, and village elders, identifying households with women aged 18-49 years in the three selected wards. The frame included 562 women in Nyongores, 427 in Kong'asis, and 296 in Siongiroi. From each ward, 50 households were randomly selected using the RAND function in Microsoft Excel, totalling 150 households (Figure 2). In each household, one woman aged 18-49 years responsible for food decisions was chosen for the study. Respondents dropped out in the course of the study period due to refusal to continue and relocation. Those who remained to the end of the study were 34, 46 and 38 in Nyongores, Kongasis and Siongiroi respectively, a total of 118 respondents. Figure 3 indicates aattrition at each stage, along with the reasons for dropout.

Data Collection Tools

Before the intervention, a baseline survey was conducted using semi-structured questionnaires to gather data on the WRA's demographic and socioeconomic characteristics, sweet-potato production practices, and consumption of sweet-potato leaves. Dietary data, including food consumption and iron intake, was collected via 24-hour dietary recalls at baseline, weeks 4 and 8, and after the 12-week intervention. The multiple recall questionnaires were collected from at least two weekdays and one weekend from each respondent. To improve the accuracy of these recalls, standardized household measures, like cups, plates, and spoons, were used, and respondents were shown a food album with portion-size photographs to aid in estimating the quantities of foods consumed.

Data Collection Procedures

The pre-intervention phase took place from February to March 2022. During this period, respondents were sensitized about sweet-potato agronomic practices. Sweet-potato vines were provided to women, along with guidance on planting. Additionally, participants attended cooking demonstrations involving sweet-potato leaves, during which they developed recipes to prepare sweet-potato leaf vegetables. The intervention study was conducted from April to August 2022. Participants received training at weeks 1, 4, and 8, with instructions on how to incorporate sweet-potato leaves into their diet. They were encouraged to consume sweet-potato leaves vegetable at least three times per week, based on Gopaldas (2002). Since participants were not accustomed to the vegetable, it was not intended to be an everyday meal. To support adherence, standard short messages were sent every other day, reminding respondents to include sweet-potato leaves in their meals. Weekly follow-ups were checked on the availability of sweet-potato leaves, consumption frequency, and any challenges faced during preparation and intake. At the end of the 12-week intervention, face-to-face interviews were conducted during the end-line survey, targeting participants who had completed the study. The semi-structured questionnaire from the baseline survey was adapted for this purpose, and a 24-hour dietary recall was also administered to assess dietary changes.

Figure 2:
Summary of the Intervention Study

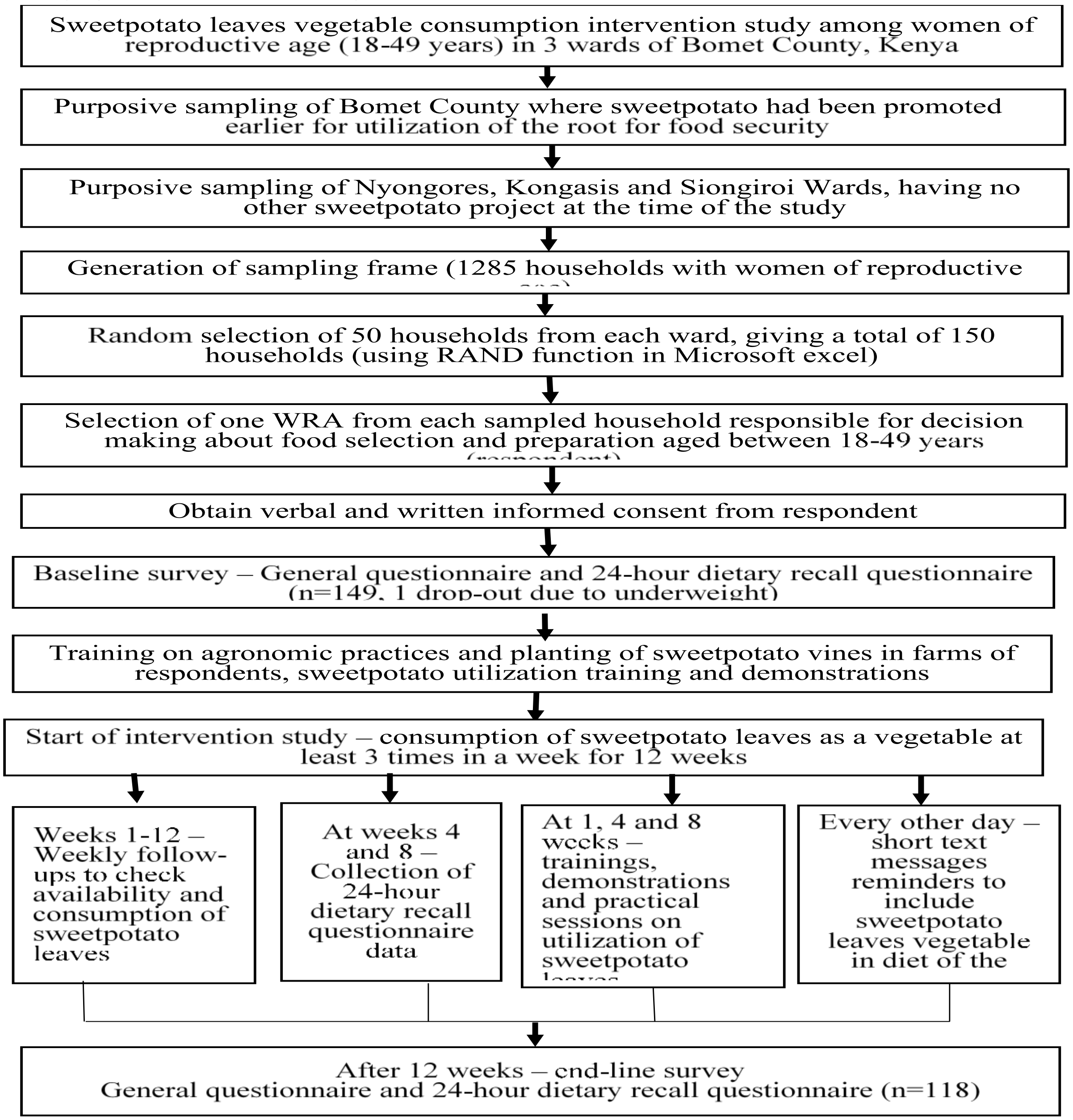
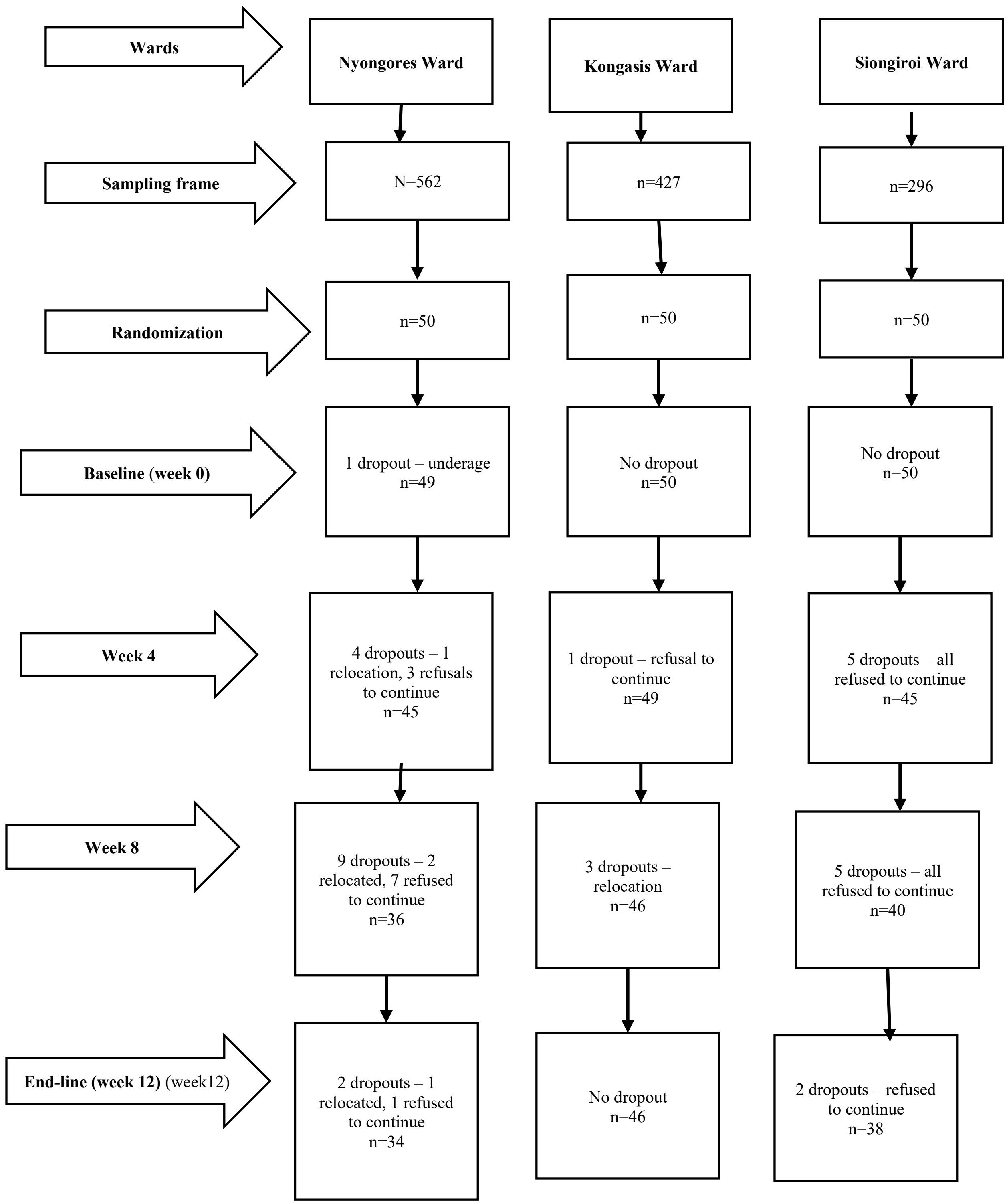


Figure 3 gives a summary of initial sample size, drop-outs at every stage and the reasons for dropping out and the final sample size of the respondents.

Figure 3:

Summary of Respondents Who Dropped Out and Reasons for Dropping Out of the Study



Data Analysis

Analysis was conducted exclusively on participants who completed the study to compare baseline and end-line data, thereby reducing potential bias associated with attrition. An attrition rate was reported, and the remaining participants achieved the calculated sample size, ensuring adequate statistical power for the analysis. Data cleaning, management and analysis was carried out using the Statistical Package for Social Scientists (SPSS) (International Business Machines [IBM] SPSS 22.0) computer program. Prior to data analysis, information obtained from the 24-hour dietary recall on the amount of food and beverage consumed by the respondents was calculated using the Kenyan Food composition Tables (Food and Agriculture Organization of the United Nations & Government of Kenya, 2018) where food values were imported into Nutrisurvey software. Foods were first converted into grams then entered into the NutriSurvey for windows computer software for conversion of foods taken into nutrient intakes (Juergen, 2014). The data was then run to obtain the contribution of each food to iron intake. Respondents' descriptive data were represented in frequencies and percentages. Continuous data are represented in means and standard deviations. Means of different were compared using Analysis of Variance (ANOVA) for groups with variables that were continuous and with normally distributed data and means separated by Bonferroni post-hoc test with statistically significant levels of $p \geq 0.05$. Kruskal Wallis test was used to compare non-parametric data.

Ethical Considerations

Research ethical approval for the study was obtained from Egerton University Research Ethical Committee (EUREC) (Protocol code: EUREC/APP/153/2021), while the Research permit to conduct the study was obtained from the National Commission for Science, Technology and Innovation (NACOSTI) (License No. NACOSTI/P/22/14901). Informed verbal and written consents were obtained from the respondents before commencement of the study.

RESULT

Demographic and Socioeconomic Characteristics of the Study Population

Results about the demographic and socioeconomic characteristics of the study population are summarized in Table 1. A total of 118 respondents completed the study, of which 34, 46, and 38 were from Nyongores, Kongasis, and Siongoroi Wards, all in Chepalungu sub-County, Bomet County. Overall, the ages of the respondents ranged from 20 to 49 years with a mean age of 33.8±7.5 years. There was no statistically significant difference in the mean ages of the respondents (p=0.614) between the WRA in the three wards. The mean household size was 5.0 ± 1.67, 6.5 ± 2.25, and 5.79±2.03 in Nyongores, Kongasis, and Siongiroi persons respectively, with significant difference between the WRA in the three wards (p=0.01). Most of the respondents, about 73.5%, 87.0%, and 76.3% in Nyongores, Kongasis, and Siongiroi, respectively were married. Single women were also found in all Wards with Siongiroi Ward having the most single women (23.7%) as compared to 8.8% and 6.5% single women found in Nyongores and Kongasis Wards. However, there were no widowed women in Siongiroi Ward, while Nyongores and Kongasis had 11.8% and 2.2% widows respectively. Separated women were only found in Siongiroi Ward (5.3%) while divorced women were only found in Nyongores Ward (5.9%). Majority of the respondents in Nyongores, Kongasis, and Siongiroi Wards who had attained either some or completed primary education were 76.5%, 52.2%, and 81.6%, respectively.

Table 1:
Demographic and Socioeconomic Characteristics of Study Population

Variable	Total (n=118)	Nyongores (n=34)	Kongasis (n=46)	Siongiroi (n=38)	Significance (p=0.05)
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
Age (Years)	33.8±7.5	32.8±7.2	34.5±8.1	34.0±8.1	0.614#
Household size (No.)	5.8±2.1	5.0±1.7[b]	6.5±2.3[ab]	5.8±2.0[a]	0.01#
Marital status (%)					
Married	78.9	73.5	87.0	76.3	0.157*
Divorced	2.0	5.9	-	-	
Widowed	4.7	11.8	2.2	-	
Single	13.0	8.8	6.5	23.7	
Separated	1.4	-	4.3	-	
Level of education (%)					
Some primary	31.1	41.2	2.2	50.0	0.620*
Completed primary	39.0	35.3	50.0	31.6	
Some secondary	13.4	8.8	26.1	5.3	
Completed secondary	7.1	2.9	13.0	5.3	
College/university	9.5	11.8	8.7	7.9	
Occupation of household head (%)					
Crop farming	7.9	11.8	6.5	5.3	0.174*
Livestock farming	1.0	2.9	-	-	
Mixed farming	19.0	23.5	15.2	18.4	
Casual labor	33.7	26.5	32.6	42.1	
Wage employment	16.4	23.5	19.6	5.32	
Business	27.0	26.1	26.1	28.9	
Occupation of respondents (%)					
Crop farming	54.3	44.1	60.9	57.9	0.827*
Mixed farming	8.9	17.6	6.5	2.6	
Casual labor	14.6	11.8	10.5	21.5	
Wage employment	1.0	2.9	-	-	
Business	15.7	20.6	8.0	18.4	
Household monthly income (Ksh) (%)					
≤3000	18.5	11.8	17.4	26.3	0.066*
3001-6000	29.7	23.5	26.1	39.5	
6001-9000	25.9	29.4	32.6	15.8	
9001-30,000	18.3	26.5	15.2	13.2	
> 30,000	7.6	8.8	8.7	5.3	

*Means in the same row with the same superscript are not significantly different, #ANOVA test at p=0.05, * Kruskal-Wallis H-test at p=0.05*

While more than a quarter (26.1%) of the women in Kongasis Ward had some secondary education, only 13.0% had completed secondary education. However, only 11.7% and 10.6% of respondents in Nyongores and Kongasis Wards had partially or completed secondary school education. In addition, less than 10% of the women in Kongasis (8.7%) and Siongiroi (7.9%) had attained college or university education whereas in Nyongores Ward they were only 11.8%. The difference in the level of education in the three Wards was not statistically significant (p=0.620). In all three wards, the predominant occupation among household heads was casual labour, followed by business and mixed farming.

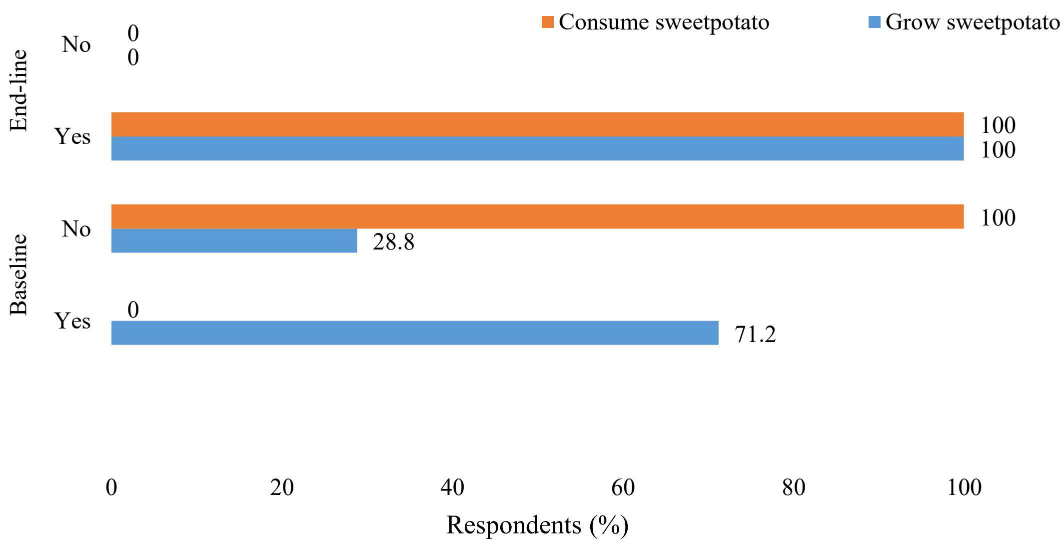
Interestingly, exclusive livestock farming was only practiced by 2.2% of household heads in Nyongores, with no practice of this livelihood in Kongasis and Siongiroi Wards. Mixed farming emerged as the most practiced occupation across all wards among the respondents. Business activities were also a source of income to 20.6% respondents in Nyongores, 8.0% in Kongasis and 18.4% in Siongiroi. However, both livestock farming and wage employment were less common among respondents. Notably, while household heads primarily relied on casual labour, the respondents were more engaged in mixed farming. Additionally, wage employment appeared to be more prevalent among the household heads compared to the respondents. The monthly household income for the majority in the study area was below Ksh 9,001. Siongiroi Ward had the highest percentage of households (81.6%) with monthly incomes below Ksh 9001 followed by Kongasis Ward (76.1%) and Nyongores (64.7%). On the other hand, only 8.8%, 8.7%, and 5.3% of the households in Nyongores, Kongasis, and Siongiroi Wards earned monthly incomes above Ksh 30,000, respectively.

Women Planting and Consuming Sweet-Potato Leaves Vegetable Before and After the Intervention Study

About a quarter of the households in the study area were not growing any sweet-potato prior to commencement of the intervention study (Figure 4). By the end of the intervention study, all the households were planting the sweet-potato crop in their farms. Additionally, none of the respondents in the study area consumed sweet-potato leaves as a vegetable in their diets before the start of the intervention study. However, at the end of the intervention study, all the women were consuming sweet-potato leaves as a vegetable as part of their diets.

Figure 4:

Percentage of Respondents Who Were Planting and Consuming Sweet-potato Leaves as a Vegetable Before and After the Intervention Study

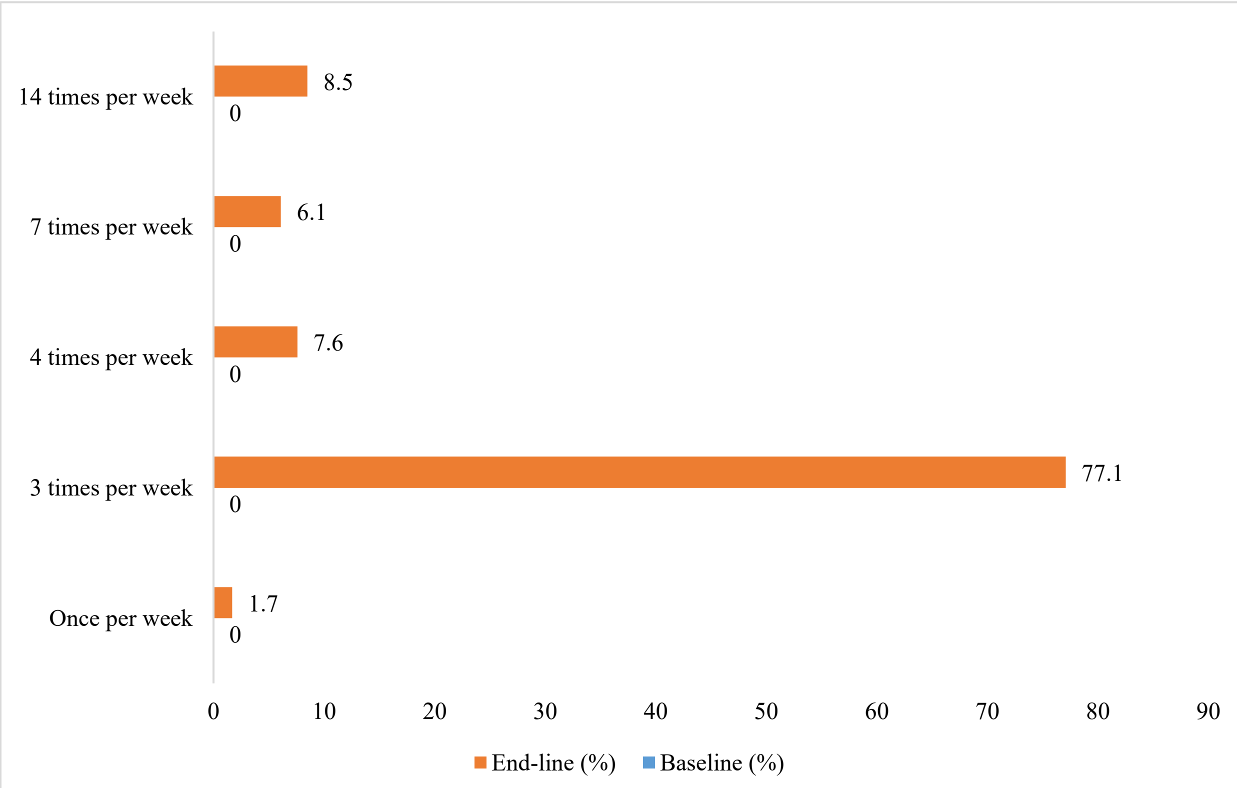


Frequency of Consumption of Sweet Potato Leaves per Week at Baseline and End-Line

The frequency of consumption of sweet-potato leaves as a vegetable before and at the end of the intervention study are given in Figure 5. The frequency of consumption was zero before the start of the intervention study.

Figure 5:

Frequency of Consumption of Sweet-Potato Leaves per Week at Baseline (Zero All Through) and End-line



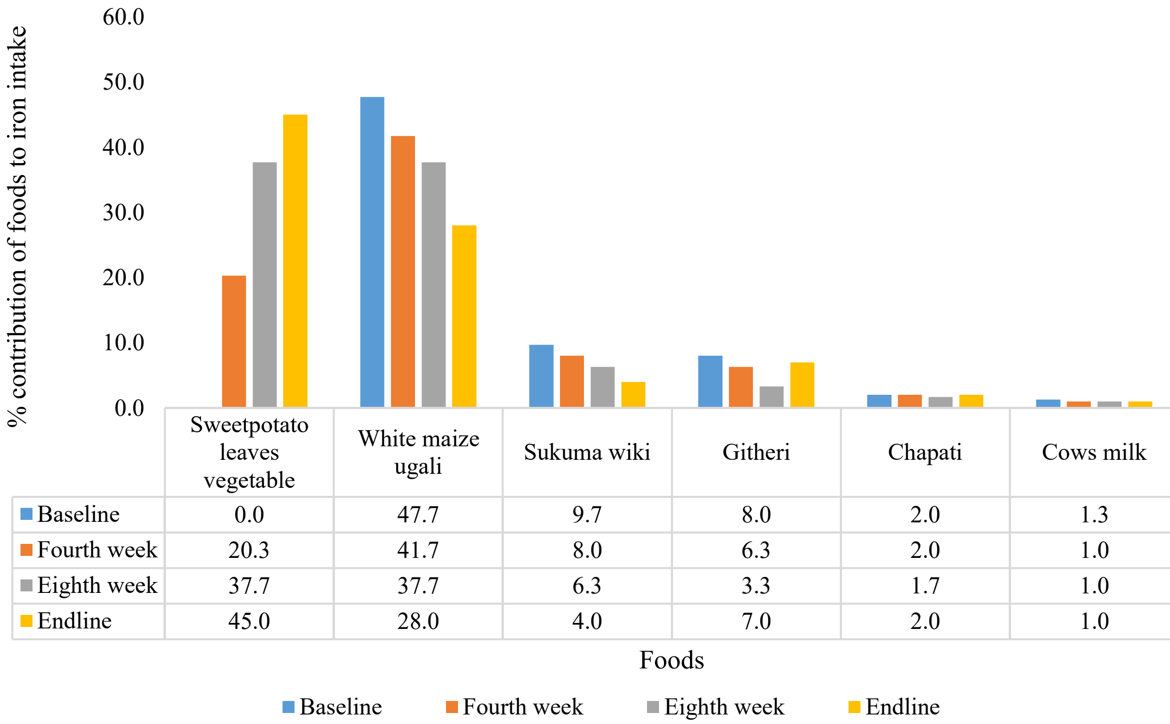
During the end-line survey, most respondents (77.1%) consumed sweet-potato leaves vegetable three times in a week. It is interesting to note that although sweet-potato leaves vegetable was a new food that was being introduced to the study group, about 8.5% of the respondents consumed sweet-potato leaves 14 times in a week.

Percentage Contribution of Different Foods Consumed to Iron Intake of WRA Throughout the Intervention Study Period

Overall, the main food item that contributed to iron intake among the respondents before the start of the intervention study was whole maize *ugali (*thick whole maize porridge), which provided up to 37%, 54% and 51% of iron intake among respondents in Nyongores, Kongasis and Siongiroi Wards, respectively (Figure 6).

Figure 6:

Contribution of Selected Foods to Iron Intake of Respondents at Baseline, Fourth Week, Eighth Week and at End-Line of the Intervention Study



	Sweetpotato leaves vegetable	White maize ugali	Sukuma wiki	Githeri	Chapati	Cows milk
Baseline	0.0	47.7	9.7	8.0	2.0	1.3
Fourth week	20.3	41.7	8.0	6.3	2.0	1.0
Eighth week	37.7	37.7	6.3	3.3	1.7	1.0
Endline	45.0	28.0	4.0	7.0	2.0	1.0

Consumption of sweet-potato leaves as a vegetable progressively increased the contribution of iron in the diet of the women at the fourth and eighth weeks. After the twelfth week of intervention study, the highest contributor of iron in the diet of the women shifted from whole maize ugali to sweet-potato leaves. Kale (*Sukumawiki*), a common vegetable in the area was also found to be an important contributor to iron intake in all three wards. *Githeri* (a mixture of maize and beans stew), chapatti and cow's milk were also important contributors of iron intake in the diets of the women.

Iron Intake of The Women Before and After the Intervention Study

Iron intake from the overall diet of the respondents increased steadily throughout the 12 weeks of the intervention study period (Table 2).

Table 2:

Iron Intakes of Women of Reproductive Age Before, After 4, 8 And 12 Weeks of the Intervention Study

Intervention period	Total (n=118)	Nyogores (n = 34)	Kongasis (n=46)	Siongiroi (n=38)	p-value*
	Mean ± SD (mg/day)	Mean ± SD (mg/day)	Mean ± SD (mg/day)	Mean ± SD (mg/day)	
Baseline	12.39 ± 5.75	11.26 ± 4.10	11.91 ± 4.93	13.99 ± 6.40	0.069
4 weeks	15.35 ± 5.65	13.51 ± 3.75	16.37 ± 6.95	15.75 ± 5.04	0.071
8 weeks	17.41 ± 5.33	15.51 ± 3.93^{b}	18.98 ± 6.41^{a}	17.20 ± 5.13^{ab}	0.019
12 weeks	19.82 ± 6.67	17.39 ± 2.81^{b}	20.30 ± 7.94^{ab}	21.41 ± 6.97^{a}	0.030

Iron intake of WRA before and after the intervention (n=118)		
Baseline	**Endline**	**p-value#**
Mean ± SD (mg/day)	**Mean ± SD (mg/day)**	**(p = 0.05)**
12.39 ± 5.75	19.82 ± 6.67	0.000

*Means denoted by different letters are significantly different according to the Bonferroni test at P < 0.05; SD = Standard deviation; *Bonferroni test; #t-test*

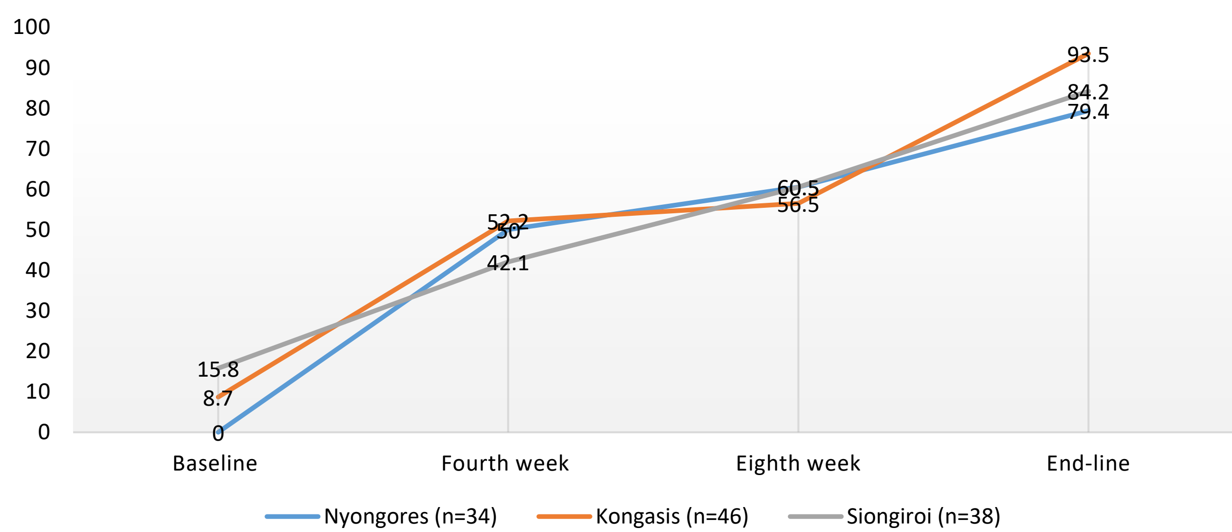
Overall, the mean iron intake of respondents from all three wards increased from 12.39 ± 5.75 mg/day at baseline to 19.82 ± 6.67 mg/day at the end of the intervention study. The mean iron intakes of all the respondents increased after one month of intervention study from 12.39 ± 5.75 mg/day to 15.35 ± 5.65 mg/day with no statistically significant difference in mean iron intakes between respondents in the three wards (p = 0.071; CI=95%). The same trend of iron intake was observed among respondents at the eighth week of the intervention study, where respondents in Nyongores and Siongiroi and those from Kongasis and Siongiroi Wards with a statistically significant difference (p= 0.019; CI = 95%). Further analysis was carried out to determine the iron intakes of respondents before (at baseline) and after the 12 weeks of the intervention study (at end-line). The results pointed an iron intake of 12.39 ± 5.33 mg/day before the start of the intervention and 19.82 ± 6.68 mg/day at the end of the intervention with a statistically significant difference in their means (p = 0.000; CI = 95%).

Nutrient Adequacy with Reference to Iron Intake

Before the intervention study, none of the WRA in Nyongores Ward met the Recommended Daily Intake (RDI) of iron. The nutrient adequacy for iron was attained by less than 10% of respondents in Kongasis and only 15.8% of respondents in Siongiroi Ward (Figure 7). However, after the 12 weeks of intervention study, approximately 80% or more of respondents in all the wards had achieved adequate iron nutrient levels. Notably, there was a steady increase in iron intake of the respondents in all the three wards throughout the study period.

Figure 7:

Nutrient Adequacy of Respondents with Reference to Iron Intake (Recommended Daily Intake for Iron ≥18 Mg/Day)



DISCUSSION

Demographic and Socioeconomic Characteristics of the Study Population

The findings from the baseline survey conducted to assess demographic and socio-economic characteristics before implementation of the intervention study indicated no significant differences in most variable among the WRA across the three wards (age, marital status, level of education, occupation of both household head and the respondent and monthly income). This homogeneity of demographic and socio-economic characteristics suggests that the sample was relatively uniform. By maintaining homogeneity among respondents, the differences in outcomes can be attributed directly to the interventions being tested, rather than to underlying variability among respondents and facilitates clearer interpretation of results and more reliable conclusions (Kazdin, 2021).

Women Planting Sweet-Potato as Before and After the Intervention Study

The results of this study indicate a significant transformation in sweet-potato cultivation among the participating women. Initially, only about 25% of respondents were engaged in planting sweet-potato es, reflecting possible hindrances to its up-take of the growing sweet-potato. Some of these limitations could be population's uncertainty on available utilization methods of the crop as well as unavailability of planting materials (Gregory et al., 2019). However, by the end of the intervention, this figure considerably rose to 100%, indicating a successful promotion effort. Research has attributed adoption of agricultural technologies to the suitability of the crop to the agroecological and socio-economic conditions (Bouis et al., 2020). Sweet-potato was adaptable to the study area due to its dual purpose for human consumption, in that both the roots and leaves can be consumed as food. Sweet-potato also thrives well in various climatic conditions including those found in the study area. It is also a high yielding crop, both for roots and leaves, hence important for production to gap food and nutrition security. It is a drought tolerant crop, resilient to pests and diseases making it easy to cultivate. However, there are limitations to consider in this study. The evaluation was conducted within a relatively short time-frame, and while the immediate results are promising, long-term sustainability of sweet-potato cultivation was not assessed. Future research should focus on the durability of this outcome, including challenges farmers may face in maintaining consistent production levels post-intervention, such as disease and pest management and extreme climate variability. The drastic increase from 25% to 100% in the adoption of sweet-potato planting illustrates the potential for targeted interventions to effect change in agricultural practices. This not only enhances food and nutrition security within the farming community but also improves nutritional levels of vulnerable groups.

Women Consuming Sweet-Potato Leaves Vegetable Before and After the Intervention Study

The intervention also resulted in consumption of sweet-potato leaves as a vegetable by all the respondents, who were initially not consuming it. It is important to note that maize, which is a staple food in Bomet County is challenged by maize necrosis lethal disease, a viral disease. Maize necrosis lethal disease is a disease that cause serious damage to maize crop and dramatic loss of yields (Zhan et al., 2022). The maize necrosis lethal disease has affected maize crops in Bomet County since 2011, threatening food and nutrition security since maize is the main staple crop in the area (Jozani et al., 2022). Farmers in such areas need to be empowered to change their mindsets and embrace growing of other crops that yield better without being affected by pests and diseases.

Sweet-potato is such a crop since it is a dual-purpose crop where both the roots and leaves are edible and nutritious. However, consumption of sweet-potato leaves vegetable was not common in the study area. This is noticeable by the fact that it was not consumed by the WRA across the three wards prior to implementation of the intervention study. Consumption of sweet-potato leaves in Kenya is rare and sweet-potato vines are considered as animal feed (Maundu et al., 2009), though it is consumed in Asian and some African Countries (Abidin, 2004; Aniekwe, 2014; Nurdjanah et al., 2019). This low consumption may stem from cultural preferences that favor other vegetables, limited availability and accessibility, a lack of awareness about their nutritional benefits and preparation methods. Consumption of sweet-potato leaves which are rich in iron is an important way of reducing the risks for ID and IDA among WRA. To address this issue, the study involved educating the respondent to raise awareness about the benefits of consuming sweet-potato leaves as a vegetable. Additionally, cooking demonstrations conducted during the intervention also helped familiarize women with preparation methods. Providing the vines and training on how to plant and other important basic agronomic practices concerning the crop enhanced availability and consumption of sweet-potato leaves by all the respondents at the end of the intervention period. Encouraging the inclusion of sweet-potato leaves and other iron-rich foods in women's diets is therefore vital for improving their overall iron status. A randomized controlled study among pregnant women emphasized the importance of intensive nutrition education on improved consumption of iron-rich diets (Wakwoya et al., 2023). The study observed no significant difference in consumption of iron-rich diet between intervention and control groups. By the end on the study, the intervention group exhibited significantly higher consumption of iron-rich foods including dark green leafy vegetables than the control group. The current study incorporated a holistic approach that combined nutrition education, practical cooking skills and increased access to the sweet-potato leaves since it has been proved effective (Bastian et al., 2021). Incorporating home gardening and training on various agricultural and nutritional aspects are also important in improving availability, accessibility and consumption of nutrient rich foods (Hernandez et al., 2022). Sweet-potato leaves and other green leafy vegetables are important sources of vitamins and minerals including iron in many parts of the world (Khatoniar et al., 2019). In addition, vegetables also contain important health properties with scientifically proven biological and pharmacological effects on the human body (Jideani et al., 2021; Kumar et al., 2020). Introducing consumption of sweet-potato leaves as a vegetable adds value to production of sweet-potato in Bomet county. However, it is important to note that, potential barriers to scaling up this food-based intervention aimed at alleviating iron deficiency may involve culturally ingrained dietary preferences that strongly influence participants' willingness to incorporate new foods.

Contribution of Different Foods Consumed to Iron Intake of WRA Throughout the Intervention Study Period

Notably, at the conclusion of the study, the consumption frequency of sweet-potato leaves as a vegetable ranged from once a week to fourteen times a week, compared to zero at the baseline. These findings indicate that the inclusion of sweet-potato leaves in the diets of the women positively influenced the eating behavior of the women. In addition, baseline results of this study disclosed that WRA in the study area depended mainly on whole maize *ugali* as their main staple food. The iron concentration in whole maize ugali is 1.1 mg per 100 g (Food and Agriculture Organization of the United Nations & Government of Kenya, 2018), indicating that maize is not a significant source of iron. However, whole maize *ugali* was a major contributor of iron in the diet of the women since it was consumed in large amounts. Before the onset of the intervention study, whole maize *ugali* provided approximately 47% of the overall iron intake for the women, while sweet-potato leaves vegetable did not contribute to any iron intake. However, by the end of the intervention study, the contribution of iron from whole maize declined and accounted for about 26% of total iron intake, while the contribution of iron intake from sweet-potato leaves increased steadily to around 46% among the WRA who participated in the study. This change clearly demonstrates that adding sweet-potato leaves to the diets consumed by WRA played a significant role in increasing the iron intake among the women. Dark green leafy vegetables such as sweet-potato leaves, are notable for their high iron content. In the variety examined in this study, 100 grams of cooked sweet-potato leaves provide approximately 9 mg of iron (Cheboswony et al., In press), significantly higher than the 1.1 mg found in 100 grams of whole maize *ugali*. This suggests that even small portions of sweet-potato leaves can meet iron requirements more effectively than whole maize *ugali*. Notably, Sweet-potato leaves are also rich in vitamin C, which promotes iron absorption, making them particularly beneficial for individuals who may not consume adequate amounts of iron from animal origin foods that are readily absorbed by the body. In contrast, maize is lower in iron and contains phytates that inhibit absorption. Moreover, sweet-potato leaves contain other important nutrients such as beta carotene, folate, calcium, fibre, proteins, antioxidants and phytochemicals (Oboh et al., 2023) that contribute to improved overall Health. Furthermore, sweet-potato is a drought tolerant crop making its leaves readily available year-round and a cost-effective source of essential nutrients. Consumption of sweet-potato as a vegetable also replaced the commonly consumed kale in the study area. Kale is a vegetable that is commonly star-fried and consumed as a side dish with other starches in most parts of Kenya. A hundred grams of star-fried kales provide 2.3 mg of iron, compared to about 9.0 mg provided by 100 g of cooked sweet-potato leaves vegetable (Food and Agriculture Organization of the United Nations & Government of Kenya, 2018). Other foods that were among the main contributors of iron intake in the diets of the women included *githeri,* chapatti and cow's milk. Unlike sweet-potato leaves, the other foods that notably contributed to iron intake in the diets had lower iron intake when compared to equal amounts of the food. Considering 100 g of the foods, *githeri* contains 2.2 mg of iron, white chapatti contains 3.9 mg while cow's milk contains 3.9 mg per 100g. Sweet-potato leaves vegetable is therefore superior in iron content to the other foods that were consumed by the women.

Iron Intake of the Women Before and After the Intervention Study

Iron intake of the women also improved with the intervention study. At baseline, women's average iron intake was 12.4 mg/day, which increased steadily to about 15.4, 17.4 and 19.8 mg/day after four, eight and 12 weeks of the intervention study respectively. The outcome of this study provided important information on targeting dietary interventions aimed at promoting behaviour change in terms of consumption of iron rich foods such as sweet-potato leaves, and that such can effectively improve iron intake of WRA. A cross-sectional study was conducted to examine the consumption of dark green leafy vegetables and its relationship to iron intake. The study focused on small-scale female farmers in Tanzania aged between 29 and 45 years, yielding similar findings (Stuetz et al., 2019). The study reported that the quantity of vegetables consumed was the main determinant of iron intake with improved overall health for the women.

Nutrient Adequacy with Reference to Iron Intake

Before the intervention study, less than 10% of WRA met their recommended daily intake for iron which is 18 mg/day (FAO & WHO, 2001). By introducing and promoting consumption of sweet-potato leaves as a vegetable as part of the diets contributed to a steady increase of iron intake and nutrient adequacy to an average of 86.4% at the end of the intervention study. Overall iron intake among the WRA was about 12 mg/day, which was also much below the recommended daily allowance of 18 mg/day. Due to consumption of sweet-potato leaves, the overall iron intake of the women rose to about 19 mg/day, indicating that the women met their recommended daily allowance for iron set at 18 mg/day. Minimal studies have been conducted on influence of sweet-potato leaves consumption on iron intake and status of WRA. However, a study on consumption of green spinach by pregnant women in a quasi-experiment significantly improved their iron intake and status (Natalia et al., 2019). Other studies done on consumption of amaranth leaves have given evidence of improved iron intake and status among various groups (Yilma et al., 2025).

Limitations

The study faced limitations that call for consideration. Primarily, the absence of a control group limits the ability to definitively attribute observed changes to the intervention, as external factors may have influenced the outcomes. However, the pre- and post-intervention design still provided important insights contribution of sweet-potato leaves to iron intake of the women over the 12-week period. Secondly, data collection relied on self-reported 24-hour dietary intake, which introduces the possibility of measurement bias due to recall inaccuracies. To improve on the accuracy of the data, repeated 24-hour dietary recalls, covering two weekdays and one weekend day offered a detailed assessment of participants' iron intake. To further improve the accuracy of data collected from the 24-hour dietary recall, standardized household measures tailored to the study area were developed, based on measurements used within the community for both measuring and serving food. Additionally, a food album featuring pictures of foods in different portion sizes was created and shown to women during the 24-hour dietary recall data collection, enhancing the precision of food quantity estimations. Additionally, the duration of 12 weeks restricts assessment of the long-term sustainability of dietary changes though it allowed for an initial evaluation of dietary changes. External confounding variables, such as seasonal variations or other concurrent health activities, could also have affected the results. Participant attrition posed a notable challenge; out of the initially recruited participants, 32 dropped out, with the highest dropout observed in the Nyongores ward (26 participants), followed by Siongiroi (12 participants), and Kongasis (5 participants). Despite this attrition, each ward initially met the target sample size, supporting the validity of the comparisons across sites. While these limitations should be acknowledged, the results offer valuable insights regarding the potential effects of the nutritional intervention within a community setting.

Conclusion

This study observed that none of the WRA consumed sweet-potato leaves as a vegetable prior to implementation of the intervention study, hence sweet-potato leaves did not contribute to their iron intake. However, at the end of the intervention period, all the women had incorporated sweet-potato leaves as a vegetable in their diets, and which subsequently contributed the most iron intake in their meals. The overall iron intake of the women also improved significantly with consumption of the introduced sweet-potato leaf vegetables. This study provides support of beneficial contribution of sweet-potato leaves vegetable to iron intake and supports their inclusion as a nutritious option in the diet of the women. Hospitals and other healthcare providers can adopt this technology by incorporating sweet-potato leaves vegetable as an additional nutritive option. The vegetable can play a vital role in addressing nutritional deficiencies such as IDA and enhance women's health outcome.

Recommendations

There is need for policymakers to promote the integration of sweet-potato leaves into national nutrition strategies, highlighting their health benefits. It is also essential for stakeholders such as the ministries of Health and Agriculture to promote awareness and integrate sweet-potato leaves into nutrition programs, emphasizing their health advantages. National and County governance, and other relevant private sectors need to facilitate extension officers and community workers to training community members on production and utilization of sweet-potato leaves to encourage household consumption. Additionally, government's support for research and community initiatives will increase the supply and adoption of this nutritious leafy vegetable. There is also need for further research that include longitudinal follow-up studies to assess the long-term impacts of sweet-potato leaves as a vegetable on overall nutrient status of the women. Additionally, assessment of iron bioavailability is necessary to better understand the effectiveness of sweet-potato leaves in improving iron status.

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CONFLICT(S) OF INTEREST

The authors declare no conflicts of interest

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