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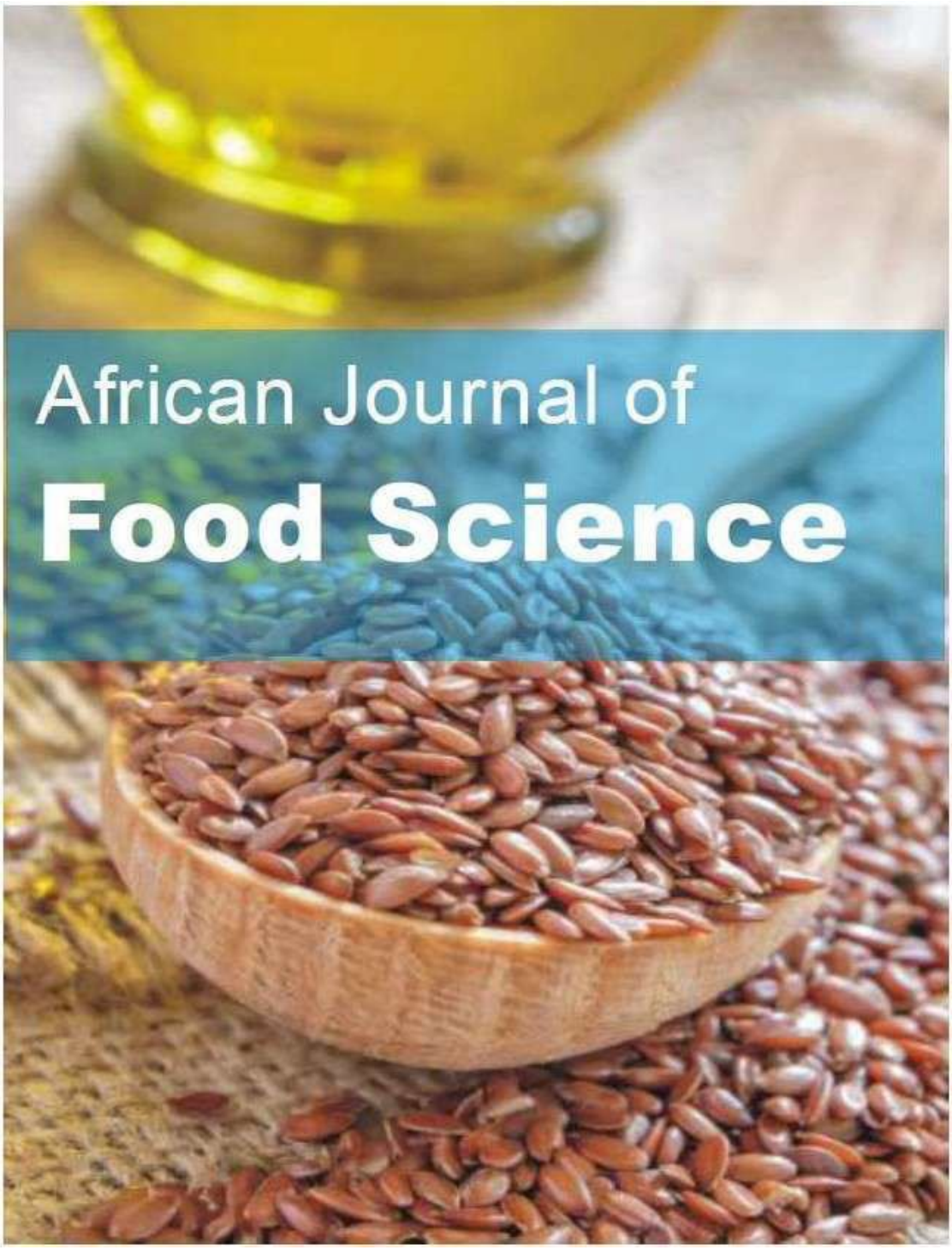

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Full Length Research Paper

Food safety practices of cooked food hawkers in Tharaka Nithi County, Kenya

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Hawking of cooked foods is an important economic activity, especially for low-income earners. However, the trade raises public health concerns particularly due to the likely breaches of food safety standards. Thus, this study investigated the food safety practices of hawkers of cooked foods in Tharaka Nithi County. A cross-sectional study design was used to collect data from 151 respondents using a questionnaire. The other data collection tools included a key informant interview guide and an observation checklist. The mean age of hawkers was 40.25 ± 9.226 years, with 71.5% of them aged between 35 and 59 years. The majority of hawkers were females (77.5%), married (51.7%), had attained secondary level education (55.6%), and earned a daily profit of between Ksh. 501 and 1,000. The hawkers were largely (91.1%) not trained on food safety, did not have a food hygiene license (92.7%), did not wear outer garments (58.9%), and did not have a medical certificate (89.5%). Almost half (54.2%) of the hawkers prepared their foods at home and transported them to hawking sites using public means (52.6%). The majority (86.8%) of hawking sites were makeshift stations and 40.4% of them had reportedly been infested with rodents. Generally, the hawkers did not comply with most of the food safety standards. County government of Tharaka Nithi should therefore design and implement interventions to promote the safety of cooked foods hawked in the county.

Key words: Handling practices, hawkers, cooked, food safety, street foods, street vendors.

INTRODUCTION

A hawker is a person who sells goods by moving from place to place (Oxford Learner's Dictionary, 2021). In the perspective of food safety, hawking is contextually comprised of preparation, sale, or display for sale of foods in open environments or makeshift structures within the streets commonly referred to as street food vending. Hawking of cooked foods is a common and old worldwide phenomenon. In fact, food hawking has been significant in the growth of local economies for several countries including Bangkok (Kusakabe, 2015), Singapore (Tarulevicz, 2018; Squarzon, 2017), Ghana (FAO, 2016), South Africa (Khuluse and Deen, 2020) and Kenya (Mongei and Naitore, 2019; Adhiambo, 2016; Odundo et al., 2018). The growth in food hawking is driven by factors

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such as low costs, high nutrition value, ability to allow for variation in consumer diets, and ease of access of the hawked foods, both in urban and rural settings (Maroko, 2016; Moussavi et al., 2016). More importantly, food hawking provides an opportunity for self-employment using relatively little capital and is hence instrumental for developing business skills especially for the economically disadvantaged segments of the community (FAO, 2016; Nicholas, 2019).

In spite of the social and economic benefits of food hawking, studies have also pointed to food safety concerns particularly due to the associated challenges in compliance with food safety standards. Hawking of cooked foods usually occurs in high traffic streets such as bus terminals, industrial areas, construction sites, and roadsides. Sometimes, hawkers of cooked foods move from street to street, house to house, or even follow moving vehicles during heavy road traffics selling their foods (Hussein, 2014). The hawking practices and environments in which cooked foods are hawked pose inherent challenges in compliance with food safety standards. The problem is further confounded by inadequate regulation from the government. In most countries, including Kenya, there is no clear legal framework on food hawking (Imathiu, 2017). The principal food safety law in Kenya, the food drugs and chemical substances Act (Cap 254), only prohibits selling food under unsanitary conditions and does not explicitly regulate nor illegitimate food hawking (Republic of Kenya, 2012). Consequently, food hawking presents increased chances of food contamination and thus a major public health concern. This study, therefore, investigated the food safety concerns of hawked foods, particularly in regard to hawkers' food handling practices and the environmental conditions of the hawking stations. There was barely any documented information regarding hawkers' food handling practices and environmental conditions of cooked foods' hawking stations in Tharaka Nithi County thus the study provided important information to guide targeted policies and interventions by actors in food safety working in Tharaka Nithi County.

MATERIALS AND METHODS

Study site

This study was carried out at Chuka town in Tharaka Nithi County. Tharaka Nithi is one of the forty-seven counties in Kenya which is composed of six sub-counties and three major urban centers, namely, Chuka, Chogoria, and Marimanti. Chuka is the largest town in Tharaka Nithi County (TNC) and hosts the majority of cooked food hawkers. It is also the most developed urban center, with the majority of social amenities and a physical development plan (TNC, 2018).

Study design

The study deployed a mixed-methods cross-sectional study design. Data were collected between January and April 2021.

Study population and inclusion criteria

The study was conducted on hawkers of cooked foods at Chuka town. In order to be considered for participation, a hawker ought to be displaying for sale a cooked food item during the time of data collection. However, those aged below 18 years were not enlisted for participation.

Sample size determination and data collection

The study carried out a census targeting the 164 cooked food hawkers at Chuka town. A route map was developed covering all the streets and, in a manner, to facilitate easy and full coverage of all cooked food hawkers in Chuka town. Research assistants followed the identified route maps and collected data from all 151 eligible cooked food hawkers available during the time of data collection. Further, the study carried out interviews with 12 key informants, 9 from the county department of public health and sanitation, and 3 from the county department of finance and revenue collection. All the key informants were interviewed from their respective offices.

Data collection tools

Data was collected using a questionnaire, an observation checklist, and a key informant interview schedule. The questionnaire was used to collect data on hawkers' socio-demographic characteristics, food handling practices, and some environmental conditions whereas the observation checklist was used to guide in gathering information on characteristics of the environment in which cooked foods were hawked and also some hawkers' food-handling hygiene practices. The key informant interview schedule was used to guide discussions with principal stakeholders in food safety. In particular, the study interviewed selected county government officials from the department of health services and sanitation and the department of finance and revenue collection. All the data collection tools were scrutinized by a team of professionals for readability, clarity, and comprehensiveness in regard to answering the research questions. Further, the tools were pre-tested at Chogoria town which has a population comparable to Chuka town in key sociodemographic characteristics. The structural facilities, management structures, and climatic conditions of Chogoria town are also largely comparable to Chuka town.

Data management and analysis

Quantitative data was coded, entered into Microsoft Excel (Ms. Excel version 2016), and validated through double-checking. The analysis was primarily carried out using Statistical Package for the Social Sciences (IBM SPSS Statistics 24) and the results were described in form of mean, range, frequencies, and percentages. Qualitative data were analyzed using the thematic network analysis technique and interpretations were made based on the source of the data and the emerging themes and sub-themes.

Ethical considerations

The ethical merits of the study were reviewed and approved by Chuka University Institutional Ethics Review Committee (reference number CUIERC/NACOSTI/078). Further, the study was licensed by Kenya National Commission for Science, Technology, and Innovation (NACOSTI) through license number 798300. Participation in the study was solely by informed consent and the participants were informed about their right to refuse to consent or

Table 1. Socio-demographic characteristics of cooked food hawkers in Tharaka Nithi County.

Variable (n = 151)	Frequency (n)	Proportion (%)
Demographic characteristics		
Sex		
Male	34	22.5
Female	117	77.5
Age (years)		
18 - 24	7	4.6
25 - 34	36	23.9
35 - 59	108	71.5
Marital status		
Single, never married	50	33.1
Currently married	78	51.7
Separated, divorced, or widowed	23	15.2
Socioeconomic characteristics		
Level of education		
Primary	48	31.8
Secondary	84	55.6
Tertiary	19	12.6
Profit earned from hawking cooked foods (Ksh.)		
0 - 500	70	46.4
501 - 1,000	81	53.6
Age of business (in years)		
> 1	9	6
1 - ≥ 3	41	27.1
3 - 7	101	66.9

to withdraw from the study at any point without prior notice or even the need to explain their action.

RESULTS AND DISCUSSION

Socio-demographic characteristics of hawkers of cooked foods in Tharaka Nithi County

The mean age of the hawkers was 40.25 ± 9.226 years, with the majority 108 (71.5%) aged between 35 and 59 years (Table 1). The findings are comparable to studies by Marutha and Chelule (2020), and Karondo and Tumaini (2021) who recorded a mean age of 39 and 38 years amongst food hawkers at Polokwane central business district in South Africa and Ilala Municipality in Tanzania, respectively. A majority (77.5%) of cooked food hawkers were females (Table 1). Studies by Salamandane et al. (2021) and Odundo et al. (2018) also recorded similar findings where females were found to comprise 77 and 60% of cooked food hawkers, respectively. The predominance of females in hawking cooked foods could be as a result of the Kenyan perspectives on gender whereby women are mostly associated with preparing foods in their respective households. The study further reveals that a majority (57.8%) of the female hawkers were either never married, or had separated from their partners. Thus, the relatively high financial obligations by the single females could also be among the factors responsible for their predominance in the business of hawking cooked foods in Tharaka Nithi County.

Almost half (51.7%) of the hawkers were married (Table 1). This proportion was within the range reported in studies carried out in Nairobi County in Kenya (Adhiambo, 2016) and Maseru city in Lesotho (Gadaga et al., 2014) where 57 and 52% of street food hawkers, respectively, were married. Just like Maroko (2016) observed in a study carried out in Nairobi County of Kenya, the dominance of married persons in food hawking in Tharaka Nithi County may well be driven by the associated relatively high number of family dependents. The majority (55.6%) of cooked food hawkers had attained secondary-level education (Table 1). These findings are consistent with a study carried out in the Philippines where a majority of 50% of respondents

Table 2. Food handling practices of cooked food hawkers in Tharaka Nithi County.

Variable (n = 151)	Frequency (n)	Proportion (%)
Trained on food safety		
Yes	15	9.9
No	136	90.1
Possess a medical certificate		
Yes	16	10.6
No	135	89.4
Possess a food hygiene license		
Yes	11	7.3
No	140	92.7
Possess a trade permit		
Yes	124	82.1
No	27	17.9
Wearing an outer garment (apron)		
Yes	62	41.1
No	89	58.9
Washes hands before handling ready to eat food		
Yes	22	14.6
No	129	85.4
A different person to handle money		
Yes	0	0
No	151	100

hawking food at Tarlac State University reportedly had attained secondary-level education (Alamo-Tonelada et al., 2018). Prabakaran et al. (2017) reported a high of 62% of food hawkers with secondary-level education. Studies by Kaptso (2021), Adhiambo (2016), and Nkosi and Tabit (2021), also documented persons with secondary-level education being the majority amongst food hawkers. In Kenya, secondary education is basically a mid-level training where learners are equipped with general knowledge in preparation for specialization in their preferred careers. Literature indicates that food hawking is a simple task that requires minimal technical skills (Moussavi et al., 2016; FAO, 2016), and this could be the reason why the majority of food hawkers comprised persons with secondary-level education. Moreover, persons with only secondary education have limited employment opportunities especially for areas that require high technical competencies.

On average, cooked food hawkers made a profit of Ksh. 541 per day. The profit earned is way above the minimum daily wage of Ksh. 367 advised for general works by the Government of Kenya (Republic of Kenya, 2018). Accordingly, the study corroborates the popular belief that food hawking is a profitable venture among small-scale businesses, and this could be among the reasons why hawking of cooked foods has blossomed in Tharaka Nithi County.

Food handling practices of hawkers of cooked foods in Tharaka Nithi County

A majority of 91.1% of hawkers of cooked foods in Tharaka Nithi County did not have any training on food safety (Table 2). These findings compare closely with studies carried out at Kiambu County in Kenya (Johnson et al., 2020), and Plateau State in Nigeria (Emmanuel et al., 2015) where 93 and 81.5% of food hawkers, respectively, did not have any formal training on food safety. At Dhaka University campus in Bangladesh, all (100%) food hawkers did not have any training on food safety (Farhana, 2020). In Kenya, food hawking is not directly regulated, and therefore no provisions for the training of food hawkers (Republic of Kenya, 2012). A key informant from the county department of health services and sanitation confided to this study that food hawking was discouraged in Tharaka Nithi County because of the inherent difficulties in observing food safety standards. Public Health Officers (PHOs) play a critical role in the on-job training of food handlers and therefore their perceived illegitimacy on food hawking perhaps explains why a majority of cooked food hawkers in Tharaka Nithi County were not trained on food safety. Knowledge is a very critical path for improved uptake of any desired health practice. Consequently, lack of training on food safety by the majority of cooked food hawkers compounds

the likelihood of contamination of cooked foods hawked in Tharaka Nithi County.

A majority of 92.7% of hawkers of cooked foods had not been issued with a food hygiene license (Table 2). A key informant from the public health section confided that cooked food hawkers at Chuka town and Tharaka Nithi County at large were not issued with a food hygiene license because the sites at which the foods were prepared and displayed for sale could not meet the minimum public health standards. Interestingly, a majority (82.1%) of the same hawkers of cooked foods had been issued with a trade permit by the county department of finance and revenue collection (Table 2). This finding compares strongly with a study carried out in Zimbabwe where 98.3% of food hawkers operated without a health license (Njaya, 2014). In Cameroon, a high of 60% of food hawkers had also not been licensed (Kaptso, 2021). Generally, a food hygiene license in Kenya is issued by the department of public health only to businesses that have complied with the basic food safety standards while a trade permit is issued by the department of finance and revenue collection as a means of raising revenue by the counties and government at large. A food hygiene license is a basic requirement for any person selling food to the public and without which a business cannot be issued with any other trade permits (Republic of Kenya, 2012). Thus, the findings of this study point to an outright discord between two government departments in regard to the licensing of hawkers of cooked foods in Tharaka Nithi County. In fact, a key informant from the section of public health confided that their efforts to discourage hawking of cooked foods in Tharaka Nithi County were somewhat frustrated by the virtue that cooked food hawkers were issued with trade permits by the county department of finance and revenue collection which by and large legitimized the business.

In this study, 58.9% of hawkers of cooked foods did not wear outer garments when handling food (Table 2). Similarly, studies by Adhiambo (2016), Mlay (2018), Were et al. (2020), and Hossen et al. (2021) observed that a majority of 55, 61, 75, and 90%, respectively, of food hawkers did not wear outer garments while handling food. Outer garments are a form of personal protective clothing that prevents cross-contamination of ready-to-eat food from contaminants lodged on the ordinary clothes of food handlers. Consequently, the findings of this study point to increased chances of contamination of cooked foods from the hawkers' ordinary clothing.

This study observed that a majority of 89.5% of hawkers of cooked foods did not have a medical certificate (Table 2). According to a key informant from the county department of public health and sanitation, hawking of cooked foods is not allowed as per the food, drugs and chemical substances Act (cap 254 LOK) and therefore food hawkers could not qualify for medical certificates. Similarly, a study conducted in Southern Sierra Leone found that a high of 85.1% of hawkers of cooked foods did not have a health certificate (Lamin-Boima, 2017). Similar observations were also documented by Were et al. (2020) and Adhiambo (2016). The situation was even worse in Kayole location of Nairobi County where 96.4% of food hawkers did not possess a medical certificate (Maroko, 2016). In Kenya, like other countries, food safety and quality standards prohibit persons suffering from infectious diseases from handling ready-to-eat foods meant for public consumption. Indeed, existing literature indicates that food hawkers are potential carriers of pathogenic microorganisms such as *Salmonella, Shigell*a, among others (Moloi et al., 2021). A medical certificate is an affirmation that a person has been examined and found medically fit to prepare or sell ready-to-eat foods to the public. The findings of this study thus implicate hawkers of cooked foods in breach of food safety and quality standards which subjects cooked foods hawked at Chuka town to increased chances of microbial contamination. As a matter of fact, key informants observed that hawking of cooked foods in Tharaka Nithi County was carried out in total disregard of public health standards and thus predisposed consumers to food-borne diseases.

In the current study, a paltry 14.6% of hawkers of cooked foods washed their hands before handling ready-to-eat foods (Table 2). Similarly, a study by Nkosi and Tabit (2021) observed that a minority of 43% of food hawkers at Zululand District in South Africa washed their hands before handling ready-to-eat foods. Washing hands is a universally recommended and tested cheap, efficient, and cost-effective way of preventing diseases. As such, failure to wash hands by the majority of hawkers of cooked foods predisposes the foods to increased odds of contamination, especially by microbial contaminants. Worse also, all (100%) the cooked food hawkers in Tharaka Nithi County did not have a separate person to handle money from customers (Table 2). Similarly, studies by Bereda et al. (2016) and Eliku (2016) observed that all (100%) food hawkers handled money while at the same time serving food to customers. Existing literature implicates the handling of money in microbial contamination of foods (Amankwahkuffour et al., 2015). Consequently, cooked foods hawked in Tharaka Nithi County are at an increased risk of cross-contamination from contaminated money.

Environmental conditions of the hawking sites for cooked foods in Tharaka Nithi County

More than half (54.3%) of the hawkers prepared their foods at home, while the rest prepared their foods at the hawking sites (35.7%) or licensed food premises (10%) (Table 3). These findings are consistent with studies by Kaptso (2021) and (Lamin-Boima, 2017). The sanitary conditions of foods prepared at homes cannot be assured (Kaptso, 2021) while hawking sites are basically

Table 3. Environmental conditions of the hawking sites for cooked foods in Tharaka Nithi County.

Variable	Frequency (n)	Proportion (%)
Food preparation site (n = 151)		
Home	82	54.3
Hawking site	54	35.7
Licensed food premise	15	10
Means of food transportation (n = 97)		
Public vehicle/motorcycle	51	52.6
Private/Walking (in a bucket or trolley)	46	47.4
Source of raw materials (n = 151)		
Formal business/home farm	126	83.4
Informal business (black market)	25	16.6
Storage of garbage (n = 151)		
In a municipal receptacle/standard dust bin	96	63.6
In a carton/sack/indiscriminate dumping	55	36.4
Source of cooking utensils (n = 151)		
Informal sector (jua kali)	61	40.4
Formal sector	90	59.6
Presence of vectors or other pests of public health importance at the hawking site (n = 151)		
Yes	90	59.6
No	61	40.4
Mode of hawking of cooked foods (n = 151)		
Move from street to street	20	13.2
In a stationary point	131	86.8
Hawking site exposed to open environment (n = 151)		
Yes	151	100
No	0	0
Ready-to-eat food covered (n = 151)		
Yes	131	86.8
No	20	13.2

makeshift stations exposed to contaminations from the open environment and mostly lacking essential food safety facilities (Kariuki et al., 2018; Ceyhun and Şanlıer, 2016). Indeed, the food, drugs, and chemical substances act require that all foods meant for public consumption should be prepared from licensed food premises in order to minimize the chances of contamination (Republic of Kenya, 2012). Cooked foods hawked in Tharaka Nithi County were therefore at an increased risk of contamination since the majority (90%) were prepared at either homes or unlicensed hawking sites.

Utensils used to cook foods hawked in Tharaka Nithi County were sourced from either the informal sector (40.4%) or the formal sector (59.6%) (Table 3). These findings are consistent with observations by Khairuzzaman et al. (2014) that utensils used for preparing foods vended at the streets are sourced from both the informal and formal sectors. Unfortunately, utensils from the informal sector, popularly known as the “jua kali sector”, are usually fabricated from old metallic materials which are prone to leaching of heavy metals (Khairuzzaman et al., 2014). Consequently, foods cooked with utensils sourced from the “jua kali” sector are subject to contamination with heavy metals. Some (16.6%) of hawkers of cooked foods relied on low-quality raw materials from the informal sector as well (Table 3). Bhutan Agriculture and Food Regulatory Authority (2014) pinpointed the use of substandard raw materials as a critical concern in the informal food sector. Studies have shown that food ingredients from the informal sector

mostly contain chemicals and other toxins in quantities above the recommended limits (Rane, 2011). In view of this, cooked foods hawked in Tharaka Nithi County are at risk of contamination with heavy metals and other toxins from the raw materials sourced from the informal sector. Once cooked, a majority (52.6%) of the foods were transported to hawking sites using a public vehicle or a public motorcycle (Table 3). Food transportation is an important “critical point” at which food contamination can occur (Alimi, 2016). Indeed, the hygiene standards of public vehicles and public motorcycles cannot be guaranteed. Consequently, foods hawked in Tharaka Nithi County are increasingly likely to be contaminated with pathogenic microbes or heavy metals from public vehicles and public motorcycles.

The majority (86.8%) of respondents hawked their cooked foods at temporary stationary points while the rest (13.8%) hawked the foods by moving from one street to the other (Table 3). On the contrary, a study carried out at Barishal city in Bangladesh observed that a comparatively small proportion of 25% of respondents hawked their foods at stationary points while a majority of 58.3% hawked the foods by moving from one point to the other (Rahman, 2019). In terms of garbage management, it was revealed that 36.4% of hawkers of cooked foods stored their garbage in cartons, sacks, or dumped indiscriminately while 64.6% stored garbage generated from food hawking in environmentally sensitive methods such as in municipal receptacles or standard dust bins (Table 3). These findings compare strongly with a study carried out in South Africa where 38% of food hawkers used substandard bins to store garbage while 11.8% had no means of storing garbage at all (Marutha and Chelule, 2020). In Tanzania, a high of 55.1% of food hawkers sometimes disposed their garbage indiscriminately (Mlay, 2018). Poorly managed garbage is known to provide a conducive environment for breading of disease vectors such as flies and rodents. This study also revealed that 13.2% of hawkers did not cover the cooked foods during display (Table 3). These findings are in close agreement with a study by Okojie and Isah (2014) where 10.8% of hawkers displayed their foods in open containers. The proportion of hawkers who did not cover their foods during hawking was even higher (31%) at Delhi city in India (Sachdev, 2017) and Hawassa city (51%) in South Ethiopia (Temesgen and Nune, 2016). Just like poorly managed garbage, exposed ready-to-eat foods usually attract flies and other rodents that use the food for resting, habitat, or mostly for their meal (Mlay, 2018). Accordingly, a markedly high number (40.4%) of hawkers reported seeing rodents or other pests of public health importance in the hawking sites (Table 3). These findings are consistent with a study carried out by Alamo-Tonelada et al. (2018) where food hawkers reported sometimes seeing pests in the hawking sites. In Nigeria, a high of 85% of food hawkers at Owerri reported presence of vectors in their hawking sites (Iwu et al., 2017). Likewise, Hassan and Fweja (2020) reported presence of pests at food hawking sites although at a relatively small proportion (23.4%) compared to the findings of this study. Some of the pests are known mechanical or biological disease vectors. Accordingly, these findings point to a somewhat high risk of contamination of cooked foods hawked in Tharaka Nithi County from these pests. Indeed, key informants observed that hawking of cooked foods at in Tharaka Nithi County was carried out in environments prone to contamination.

Conclusion

The majority of hawkers of cooked foods in Tharaka Nithi County do not observe the basic food safety requirements. Consequently, hawked cooked foods in Tharaka Nithi County present an increased risk of contamination, particularly from pathogenic microbes, harmful chemicals, or foreign materials introduced into the foods through poor food handling practices and unsanitary hawking environments. In order to protect the public from related foodborne diseases, the county government of Tharaka Nithi should develop and implement comprehensive targeted interventions.

Recommendations

The county government of Tharaka Nithi in collaboration with relevant stakeholders to develop and implement a policy on hawking cooked foods in the county. The policy should address all the safety concerns of hawking cooked foods, with some of the priority intervention areas being building the capacity of cooked food hawkers, and securing the hawking environments.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Nutrient composition of selected seasonal food delicacies in Malawi

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Five locally available seasonal delicacies in Malawi were analysed for their nutrient content. The five delicacies included three insect types, one bird and a plant tuber. The proximate analysis using standard methods of analysis showed that *Nomadacris septemdasciata* (insect) has the highest protein content (69.78±2.0%) followed very closely by *Passer difusus* (bird) (67.59±1.2%). The protein content of the *Nomadacris septemdasciata* and *Passer difusus* is significantly differently from the rest of the food items. In the case of fat content, the results showed that *Carebara vidua* (insect) has significantly the highest amount (33.38±0.3%). The mineral analysis indicated that *Passer difusus* (bird) (516.68 ±8.6 mg/100 g) has significantly the highest amount of phosphorus followed by that of *Homorocoryphus vicinus* (insect) (359.53 ±6.2 mg/100 g). For Iron, *Satyrium buchanii* (plant) has significantly the highest content (37.31±1.4 mg/100 g). These results showed that consumption of the seasonal edible insects, birds and plants can provide the much-needed nutrients for proper growth throughout the year.

Key words: Nutrient, seasonal delicacy, edible insects, diet, food insecurity.

INTRODUCTION

In Malawi nutrition assessment data continue to show cases of chronic malnutrition (NSO and ICF, 2017). This is largely due to low income levels common to both urban and rural dwellers. Therefore, many households in Malawi experience food insecurity. A study by Thakwalakwa et al. (2020) showed that household food insecurity was associated with lower intake of grains, fruits, meat and eggs, oil/fat and snacks.

The indigenous diet of most people in Malawi is distinctively varied depending on the geographical location, affluence, ethnicity and religious inclination to some extent. Certain food items are eaten across all these distinct groups of people. Therefore, various plants, animals and insects derived products are major components of the diet. Generally, most of the plant and animal sources used in the diet are locally grown or raised by humans. However, some of the plant and animal derived food materials are derived from wild sources just like the edible insects (Kelemu et al., 2015). Most of these food items are seasonal in nature and are a sought-after commodity at a particular time in the country. Since it is possible to obtain these food items at different times of year this allows one to have a reasonable supply of nutrients throughout the year.

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Food items that are obtained from the natural environment include insects, insect larvae, eggs, mammals, birds, wild tubers, fruits and leaves. Collection of food items from environments is generally on the decline due to intensive land clearing as a result of urbanisation and need for farming space. Most of the insect populations thrive in dense forest and thick grass bushes that are fast disappearing due to massive land clearing for farming and urban development. In some countries efforts to start commercial faming of these insects or insect larvae are being explored (Odhiambo, 1994). Farming of some wild birds too, which were mostly sourced from the wild, for example quails, is now big business in Malawi. There is indeed need to find a sustainable way of using these valuable but underappreciated resources (Geldenhuys et al., 2013).

Insects occupy different range of environments: some emerge from the ground usually during the rainy season and others are caught in the surrounding bushes. Kelemu et al. (2015) reported that over 470 species of insects are eaten in Africa. Consumption of insects is prevalent in many countries in Africa and Asia where cases of undernourishment are rampant (Kelemu et al., 2015); Van Huis et al., 2013). It is also an important economic activity in parts of the world where people earn less than $1 per day and have difficulties accessing quality food (Folaranmi, 2012). Consumption of insects as a nutrient supplement is now being advocated by major institutions in the world more especially with regular food price increases due to reduction in production as a result of climate change and increased demand due to ever increasing world population (Van Huis et al., 2013).

In Malawi a number of insects are eaten both at larval and adult stage (Mumba and Jose, 2006). Edible insects are grouped into 8 orders which include Blattodea (cockroaches, termites), Coleoptera (beetles), Diptera (flies), Hemiptera (true bugs), Hymenoptera (ants, bees and wasps), Lepidoptera (butterflies and moths), Odonata (dragonflies, damselflies) and Orthoptera (grasshoppers, crickets and locusts) (Meyer-Rochow et al., 2021). Many researchers have reported crude protein content in insects to be ranging from 25 to 75% on dry matter (DM) basis (Oonincx and Dierenfeld, 2012). However, crude fat content falls between 10 and 70% with low carbohydrates content (Finke, 2013; Oonincx and Dierenfeld, 2012). Other authors reported that locusts, *Nomadacris septemfasciata*, popularly known as dzombe in Malawi, which fall under Orthoptera order of insects, contains 12-73% crude protein with 0.3-910 mg/100 g and 2.9±4.0 mg/100 g iron and vitamin C respectively (Hlongwane et al., 2020).

There are a number of different wild birds and burrowing mammals that are caught for human consumption. Two important seasonal animals that are readily available in large quantities are one bird species, *Passer difusus* and mice. *P. difusus* is mostly caught in rice fields during harvest time in areas where lowland rice is grown. These birds are one of the major pests in rice fields. The birds are caught during the harvest season in the months of June to July. The dressed and roasted birds can be seen being sold along the roads stacked onto a small piece of stick. The plant derived delicacy, *Satyrium buchananii* is obtained from tubers of wild orchids. It is mostly sold in the markets processed into small pan cake like. It is a popular and affordable food item to certain people and is eaten as a snack or used as relish (Kasulo et al., 2009).

The objective of this study was to analyse nutrient content of these seasonal food delicacies, *Homorocoryphus vicinus* (*Mbwanoni*), *Carebara vidua* (*Mafulufute*), *Satyrium buchananii* (*Chikande*), *Nomadacris septemfasciata* (Dzombe) and *P. difusus* (*Mpheta*) in order to enhance the nutrient data for and show the potential these food items can command in the diet of many people. With ever increasing food costs some of these food items can supplement meat and fish as the main protein source which is one of the critical food components in diets of children in Malawi. Indeed, cost has been shown to be one of the main important factors as drivers of dietary intake (Thakwalakwa et al., 2020).

MATERIALS AND METHODS

Sample collection and preparation

The samples were purchased from within Lilongwe city markets already in the prepared state and ready for consumption. The edible insect samples had their wings removed as this is not normally eaten. The samples were dried in the oven at 60°C for 48 h and were ground through a 1 mm sieve using a Thomas-WILEY model 4 Laboratory Mill (Arthur H. Thomas company, Philadelphia, USA) before doing the proximate analysis and mineral content determination.

Proximate composition

The ground samples were used to analyse for proximate composition; dry matter (DM), ash, crude protein (CP), crude fat and crude fibre (CF) using AOAC (2002) methods. Mineral composition was also analysed from the ground samples.

Dry matter using oven method

Dry matter was determined by drying the samples in a laboratory drying oven at 105°C for 5 h. The crucibles were thoroughly washed, dried in the oven (model OV-180, Blue M Electric Company, Illinois USA), cooled in a desiccator and weighed. Then, 2.5 g of the sample was weighed into the crucible and dried to constant weight. The sample DM in percentage was calculated as the fraction of the original dry weight multiplied by 100 (AOAC, 2002).

Ash using muffle furnace

Ash content was determined by igniting 2.5 g of the samples

weighed in crucibles in the muffle furnace at 550°C for 2 h. The amount of ash content in percentage was calculated using equation 1.

$$\%Ash = [(W_a-W_t)/ (W_0-W_t)] \times 100 \text{ (AOAC, 2002)} \quad (1)$$

Where W_0 is weight of crucible and sample before igniting the sample, W_a is weight of crucible and ash and W_t is weight of crucible only.

Crude protein (CP) using micro-Kjeldahl method

Nitrogen (N) content of the samples was analyzed by using micro-Kjeldahl method and the N content was converted to CP by multiplying by 6.25. The method involves digestion of the samples in concentrated (98%) Sulphuric acid, distillation of the digests into weak acids (4% boric acid) and titration of the distillates with 0.1 M Hydrochloric (HCl) acid using mixed indicator (Methyl and Bromocresol green) as an indicator (AOAC, 2002).

Crude fat

Crude fat was analyzed by extracting 2.5 g of the sample weighed in porous extraction thimbles by using petroleum ether in a Soxhlet apparatus for 16 h. The Soxhlet apparatus was equipped with a water-cooled condenser fitted above the 250 ml flat bottomed flask containing petroleum ether as fat solvent. The solvent was boiled at 40°C and fat content was calculated as a percentage of the dry weight of the sample (AOAC, 2002).

Crude fiber

Crude fiber was determined by boiling 2.0 g of the samples in 200 ml of weak Sulphuric acid (1.25%) and Sodium hydroxide (1.25%), with few drops of anti-foaming agents being added, for 30 min respectively. The residues were filtered and washed for three times with hot water, then washed with 95% ethanol and dried at 105°C for 5 h to constant weight. The dried residues were ignited in a muffle furnace at 550°C for 2 h. The crude fiber, in grams, was calculated as the difference between the weight of the residues and ash and converted as a fraction of the sample weight in percentages (AOAC, 2002).

Phosphorus determination using UV-spectrophotometer

About 1.0 g of each sample was weighed in porcelain crucibles which were ignited in a muffle furnace at 550°C to constant weight. The ash was dissolved in 3 ml of 3 M Hydrochloric (HCl) acid, transferred to 100 ml volumetric flask and diluted to the 100 ml mark (Ogungbenle and Atere, 2014). Then, 0.75 ml of the diluted digested samples were placed in 20-25ml glass vials and diluted with 9 ml of distilled water. Standards were prepared by adding 0.0 ml, 0.1 ml, 0.2 ml, 0.3 ml, 0.4 ml and 0.5 ml into 20-25 ml vials and diluted with 9 ml of distilled water. To each vial 2.0 ml of phosphovanadomolybdate /molybdate reagent (solution) was added and thereafter absorbance was measured after 1 h of color development (AOAC, 2002). Phosphorus was determined by a DR 5000 WAGTECH projects ultra-violet visible spectrophotometer (PG Industries, London, UK) at 860 nm wavelength.

Iron determination using UV-spectrophotometer

Iron composition was determined by following the Danbature et al. (2015) method with minor modification. Into porcelain crucibles 1.0 g of each sample was weighed and then ignited in a muffle furnace at 550°C to constant weight. The ash was dissolved in 1 ml of water and 5 ml concentrated hydrochloric (HCl) acid and was boiled to dryness. The solution was mixed with 3 ml of 6 M HCL and was boiled for 2 min, cooled and transferred to a 100 ml volumetric flask and diluted to the 100 ml mark. Then, 10 ml of the diluted digested samples was placed in 25 ml volumetric flasks and 1 ml of hydroxylamine hydrochloride solution was added. The solution was left to stand for 5 min after which 5 ml of acetate buffer was added followed by 1 ml of O-phenanthroline solution and then made up to 25 ml with distilled water. The solution was left to stand for 30 min for colour development. Standards were treated as the samples. Absorbance was measured at 510 nm using a DR 5000 WAGTECH projects (PG Industries, London, UK) ultra-violet visible spectrophotometer.

Statistical analysis

Laboratory chemical analyses were done in triplicates and the mean value of each parameter was calculated in Microsoft Excel Tool Pak. The data was statistically analyzed using analysis of variance (ANOVA). Two sample student t-test of the means with unequal variances was used to compare the mean and significance was accepted at $p \leq 0.05$.

RESULTS AND DISCUSSION

Proximate content

The nutrient composition of seasonal delicacies is given in Table 1. The results show different levels of the various nutrients among the three major food categories, namely plant, insect and bird. Other researchers have reported that species, stage of life, diet, habitat and methods preparation and processing affect the nutritional content of edible insects (Van Huis et al., 2013; Kinyuru et al., 2009). In the case of protein content, the results showed that *Nomadacris septemfasciata* had the highest amount of protein (69.78 ±2.0) followed by *P. diffuses* at 67.59 ±1.2%. *Homorocoryphus vicinus* and *Carebara vidua* have reasonable amount of protein content around 50%. The least amount of protein (about 3%) was observed in *S. buchananii* derived from tubers of wild orchid. Thus, the insects are a potential source of protein if included as part of the diet. The determined crude protein content fell within the reported crude protein value for insects in the range 40-75% (Rumpold and Schluter 2013; Verkerk et al., 2007). Other researchers reported that locusts, *N. septemfasciata,* contains 39.8±21.1 g/100 g locust of crude protein (Hlongwane et al., 2020). Crude protein of *C. vidua* of 53.84 ± 0.7 reported in this study was higher than 42.5% but crude fibre (9.49 ± 0.2) was closely similar to 9.1 from another similar study (Hlongwane et al., 2020). This is very significant in light of the protein consumption data which indicate that Malawi has a protein consumption rate of 51.9 g per person per day (Gilbert et al., 2019). Among the three insect types *N. septemfasciata* (grasshopper) is still obtained in large quantities compared to *H. vicinus* and *C. vidua*). This

Table 1. Nutrient and mineral content analysis of some seasonal delicacies in Malawi.

Food item	Type/ source	Dry matter (%)	Ash (%)	Fat (%)	Protein (%)	Fibre (%)	Phosphorus (mg/100 g)	Iron (mg/100 g)
Satyrium buchananii (*Chikande*)	Plant origin	84.04 ±1.4^{a}	14.42 ±0.1^{d}	0.72^{d}± 0.2	2.81±0.2^{h}	3.04 ±0.0^{l}	223.56±1.8^{q}	37.31±1.4^{u}
Nomadacris septemfasciata (*Dzombe*)	Insect	94.47± 0.4^{b}	3.00 ±0.2^{e}	2.40^{d}±0.5	69.78±2.0^{i}	6.75±0.4^{m}	75.79±3.3^{r}	4.59±0.1^{v}
Homorocoryphusvicinus (*M'bwanoni*)	Insect	95.17±0.2^{c}	6.39 ±0.1^{f}	21.65 ±1.7	51.16±0.6^{j}	7.00 ±0.2^{m}	359.53±6.2^{s}	6.65±0.1^{w}
Carebara vidua (*Mafulufute*)	Insect	98.13±0.0^{c}	2.20 ± 0.5^{e}	33.38 ± 0.3	53.84 ± 0.7^{k}	9.49 ±0.2n	224.61±1.0^{q}	3.77±0.2^{x}
Passer difusus (*Mpheta*)	Bird	97.66±0.2^{c}	11.15 ±0.1^{g}	4.92± 0.2	67.59±1.2^{h}	0.18 ±0.0^{p}	516.88±8.7^{t}	5.44±0.2^{y}

Values are mean ±standard deviation of each sample (n=3), Means with same superscript in the same column are not significantly different ($p \leq 0.05$).

makes the grasshopper to be relatively affordable in the urban setting. For those that cannot fathom the idea of eating insects then *P. diffuses* (bird) is the alternative source of protein. However, birds are relatively more expensive compared to insects. Thus, it is very clear that environmental destruction has impacted negatively on *C. vidua* available quantities. *C. vidua* is now considered an endangered species in Kenya (Ayieko et al., 2012).

Crude fat content

Fat content was highest in *C. vidua* (33.38 ± 0.3%) followed by *H. vicinus* (21.65 ±1.7%). The high fat content and the reasonable amount of protein in these two types of insects make them a potential nutritious food item to supplement other foods. Ayieko et al. (2012) in Kenya showed that *C. vidua* contain a lot of fat ranging from 42.07 to 49% depending on the body parts. The least amount of fat content was observed in *S. buchananii* (0.72± 0.2%). In terms of alternative food source for proteins and fats S. *buchananii*is may not be an ideal candidate because of the lowest crude protein content observed in this study. Consumption of the insects with reasonable amount of fats can aid in the absorption of fat soluble vitamins such as A, D and K. Consumption of oil that aid in absorption of fat soluble vitamins is low in typical tradition dishes that heavily rely on boiling in water. This level of fat consumption would complement the efforts being made in Vitamin A fortification in Malawi (Chimimba et al., 2016; Williams et al., 2021).

C. vidua had the highest amount of fibre (9.49 ± 0.2%) followed by *H. vicinus* and *N. septemfasciata (about 7%)*. The least amount of fibre was observed in *P. difusus (less than 1%)*. Fibre adds bulkiness to the food and is recommended for proper digestion. Consumption of these food items can supplement the processed foods consumed mostly in urban areas that contain few or very little fibre. The three food items with the highest fibre content are the insects compared to the animal (*P. difusus*) and plant (*S. buchananii*) food sources.

S. buchananii had the highest amount of ash (14.42 ±0.1%) followed by *P. difusus (*11.15 ±0.1*%)*. The least amount of ash was observed in *C. vidua* (2.20 ± 0.5%). Ash content is closely related to mineral content of food items and it is not surprising that *S. buchananii* and *P. difusus* had the highest iron and phosphorus content, respectively.

Mineral content

P. difusus had the highest content of phosphorus (516.88 ± 8.7 mg/100 g) followed by *H. vicinus (*359.53 ± 6.2 mg/100 g). *C. vidua* and *S. buchananaii* had medium content of phosphorus (about 220 mg/100 g) whereas *N. septemfasciata* has the least amount of phosphorus (75 mg/100 g). Phosphorus is an important element required for proper bone development and is a constituent of phospholipids and nucleotides in the cells. The nucleotides are building blocks of DNA and RNA two important biomolecules for genetic information (Serna and Bergwitz, 2020). Phosphorus is mostly obtained from milk and fish in the diet (Cordell and White, 2013). The insects are potential cheaper source of phosphorus than is milk which is consumed by only a few proportions of the population in Malawi (Akaichi and Roveredo-Giha, 2014). Malawi has a lower milk consumption rate and is ranked 142 out of 169 countries (Akaichi and Roveredo-Giha, 2014; Helgi Analytics, 2013: https://www.helgilibrary.com/indicators/milk-consumption-per-capita/malawi/). *S. buchananii* had the highest amount of iron (about 40 mg/100 g). *N. septemfasciata*, *H. vicinus*, *P. difusus and C. vidua* had comparable amount that was far

less than that of *S. buchananii. S. buchananii*is is a potential source of iron which is another important mineral required as part of blood composition. Pregnant mothers are particularly encouraged to consume foods rich in iron (Brannon and Taylor, 2017). Generally, meat and fish are the main sources of iron in the diet. However, meat and fish are relatively more expensive compared to the insects and plants that can supply this mineral. Therefore consumption of *N. septemfasciata* (Dzombe), *H. vicinus (M'bwanoni*), *C. vidua* (Mafulufute), *P. difusus* (*Mpheta*) and *S. buchananii* (*Chikande*), cheap sources of minerals, could supply required iron for pregnant women.

The seasonal nature of the food stuffs discussed here make them ideal as nutrient supplements. One can get a continuous supply of the important food nutrients from consuming these readily available and affordable food resources. In Malawi there are a number of insects and insect larvae that are very nutritious and are consumed widely. Some of these were previously reported as a remedy to fight malnutrition (Mumba and Jose, 2006). During the onset of the rain season around November/December *C. vidua* and *M. subhyanlinus* (Ngumbi) are in season up to February. In the cool months of May to July a number of insects as well as insect larvae (caterpillar) come into season. The insects such as *H. vicinus* and *P. prasina* (tsetsenya) and caterpillars such as *U. terphrichore* (Nyamanyama) and *Imbrasiaertil* (Mphalabungu) are caught. In this period mice also start to be caught. This is also the period of rice harvesting when the birds are caught. As we move to the dry months from September to December the *S. buchananii* and *N. septemfasciata* and *Chaoburus edulis* (lake flies) are in season.

As a nutrient source it has been observed that *S. buchananii* had the least nutrients compared to the other food items. Its popularity may be linked to its perceived role as a medicinal plant that is used to treat a number of illnesses in certain areas in Malawi (Kasulo et al., 2009). In other countries insects also are regarded as possessing medicinal properties for cases such as improving fertility, curing asthma, heart disease and enhancing sexual desires (Musundire et al., 2014b; Teffo, 2006). However, in Malawi this has not yet been documented. There is also need to explore new processing technologies and developing of novel food products from these natural sources. This will allow the food products for example from insects to be available throughout the year and not just at a particular time of the year (Table 1).

Conclusion

The findings from this study have revealed that insects have high nutritional value, in terms of proximate composition and mineral content, and therefore consumption of edible insects and other seasonal delicacies is beneficial for the nutritional supplement for both children and adults living with threats of chronic malnutrition. Apart from the high nutrient content in insects there is also an advantage of affordability compared to other protein sources such as fish, beef and chicken which could not be easily obtained by poor rural people. The seasonal availability of these food materials ensures a reasonable supply of essential dietary nutrients throughout the year to the poverty stricken rural people in Malawi.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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