Int. j. adv. multidisc. res. stud. 2026; 6(3):1519-1527

Received: 28-04-2026
Accepted: 08-06-2026

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Promotion of Healthy Nutrition Knowledge through Project-Based Learning of Nutrition and Food Technology: Case of Secondary Schools in Uganda

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Abstract

More than 340 million children and adolescents are overweight or obese with the prevalence increasing and expected to double among boys and more than double among girls by 2035. Using school curricula to promote authentic learning of nutrition is one sure low-cost way to combat the increasing rates of overweight and obesity. In Uganda, the Ministry of Education and Sports developed the Nutrition and Food Technology subject at secondary level to equip learners with optimal nutrition knowledge. The NFT syllabus emphasizes authentic learning of the subject through Project Based learning (PBL) using guidelines provided by the National Curriculum Development Center (NCDC) in 2021. Since PBL is newly being implemented in NFT in Uganda, there is uncertainty about how PBL promotes knowledge of healthy nutrition among secondary school learners. This was a qualitative cross-sectional survey that involved 12 secondary schools that offered NFT. Data was collected from NFT learners using self-administered open-ended questionnaires, from project group leaders using focus group discussions and from NFT teachers using key informant. Data was analyzed using ATLAS.ti 8. Results show that during NFT projects, learners mostly make unhealthy food products with a lot of added sugar, wheat, margarine and oil. Also, the majority of the reasons behind their choice of ingredients instead of being based on nutritional quality and healthiness of ingredients, are rather on making products of high sensory appeal for example used sugar to make cakes sweet and tasty, used butter and margarine to make the product soft, used baking powder to keep the product long and make it big among others. The nutrition knowledge focused on in Projects in Nutrition and Food Technology in secondary schools in Uganda is mostly on how to make palatable products of high shelf-life than knowledge of healthy nutrition. We recommend development of Project based learning resources to support food technology teachers in incorporation of knowledge of healthy nutrition in school classroom projects.

Keywords: Project Based learning (PBL), National Curriculum Development Center (NCDC), Uganda

1. Introduction

In recent years, the global significance of maintaining a healthy and well-balanced diet has gained widespread recognition. This acknowledgment stems from an increasing awareness of the pivotal role that proper nutrition plays in sustaining overall well-being and, equally importantly, in preventing a wide array of health issues (Muscaritoli, 2021) [34]. Within this global context, Uganda, much like numerous other countries, grapples with pressing nutritional challenges encompassing both overnutrition and undernutrition, in addition to a rising burden of diet-related non-communicable diseases (NCDs). This is referred to a double burden of malnutrition (Kushitor *et al*., 2020; Masibo *et al*., 2020; Reardon *et al*., 2021) [27, 29, 48]. According to Uganda Demographic Health Survey (UDHS) 2022 (UBOS, 2023) [53], among children under 5 years, stunting (24.4%), wasting (3.2%), underweight (9.7%) and micronutrient deficiencies continue to afflict a significant portion of the population, impeding healthy growth and development. 15.4% and 9% of men under 15-54 years and women under 15-49 years respectively are thin. On the other hand, the country is experiencing a concerning surge in overnutrition, marked by

increasing rates of overweight (Yaya & Ghose, 2019) [56]; 3.4% among children under 5 years. Among men 15-54 years, 9.2% and 1.5% are overweight and obese respectively while women of reproductive age, 18% and 8.4% of them are overweight and obese respectively as reported in the UDHS 2022 (UBOS, 2023) [53]. This is more prevalent in urban areas and is often accompanied by diet-related NCDs such as diabetes, hypertension, and cardiovascular diseases (Popkin & Ng, 2022) [45]. Urbanization, changing dietary patterns, and a shift towards more sedentary lifestyles contribute to this emerging health crisis (Bekele *et al*., 2020; Mittal *et al*., 2022) [4, 31].

There is already a high global public expenditure on preventing malnutrition through fortifying foods, nutrient supplementation as well as clinical based nutrition education and treatment of malnutrition with its related disorders (Olson *et al*., 2021) [42]. Using school curricula to offer nutrition education to learners can be an alternative low-cost sustainable intervention against malnutrition because it prepares a nutritionally literate future generation. In Uganda, the education sector is a signatory and key implementer of the Uganda Nutrition Action plan 11 or UNAP 11 (GoU, 2020) [17], our national framework for concerted actions and partnerships for effective and broadened nutrition interventions for better results. Specifically, strategy 2.5 bullet Six of this plan calls upon education institutions to offer nutrition education to the learners to combat malnutrition (GoU, 2020) [17]. In alignment with this objective, the current curriculum has incorporated Nutrition and Food Technology (NFT) as a subject designed to impart nutritional knowledge to secondary school learners (Nanayakkara *et al*., 2018) [35]. This subject represents a modification of the former Home Economics or Foods and Nutrition curriculum.

Unlike other teaching approaches such as group work and experimentation, the NFT syllabus now places a greater emphasis on project-based learning (NCDC, 2019, 2021) [36, 37]. When effectively applied, project-based learning in the context of nutrition and food technology has the potential to transform learners' understanding of fundamental nutritional concepts and encourage in-depth exploration (Oliveira & Cardoso, 2021) [41]. This, in turn, can lead to improved decision-making regarding food choices, meal planning, and food preparation practices, thereby contributing to the fight against malnutrition. To harness the advantages of this promising approach in addressing malnutrition, it is imperative to examine the implementation practices of project-based learning, which is relatively new to nutrition education in Ugandan secondary schools. Therefore, this study seeks to explore the diverse range of products crafted by learners as part of their Nutrition and Food Technology (NFT) projects in secondary schools across Uganda. These projects represent a significant aspect of nutrition education, where learners apply their theoretical knowledge to practical endeavors. Understanding the variety of products created offers insights into the hands-on skills and culinary expertise developed through NFT coursework.

Another critical facet under examination is the nutrition knowledge that underpins learners' ingredient choices when crafting products within the NFT projects. This aspect delves into the depth of their understanding regarding the nutritional value and implications of their ingredient selections. By assessing this knowledge, the study aims to gauge the extent to which NFT education empowers learners to make informed dietary choices, promoting healthier eating habits.

Through this investigation, the study sheds light on the practical applications of and the nutritional awareness cultivated through NFT projects in Ugandan secondary schools. These objectives collectively contribute to the broader understanding of the effectiveness of nutrition education in shaping learners' skills and knowledge, ultimately influencing their dietary decisions and promoting healthier lifestyles.

2. Methodology

This article has been written according to the Standards for Reporting Qualitative Research (O'Brien *et al*., 2014) [38].

Study Design and Data Collection

The study asked respondents to write responses to two questions that called for multiple responses (Table 1). The responses were corroborated by reviewing students' project reports. The study ran from September to Mid-October, 2023. In total, we collected qualitative data using open ended questionnaires (n = 397) as well as did content analysis of students focus group discussion transcripts. The responses were typed into a word document, checked for accuracy and uploaded onto ATLAS.ti 8.

Table 1: Survey questions

Q.	Name any product(s) you worked on during the Nutrition and Food Technology projects
Q.	Give reason (s) for any ingredients you used to make any of the products you did in your NFT projects

Data Analysis

Thematic analysis, using Braun and Clarke's approach (Braun & Clarke, 2006) [8] was used during data analysis and involves six steps that include:

1. Familiarization with the data through reading and rereading.
2. Generating initial codes using ATLAS.ti 8 that described features of the data. All 926 responses were then coded in ATLAS.ti 8.
3. Using the coding framework, that kept expanding as coding progressed to reflect the breadth of the data.
4. Searching for themes and grouping codes into potential themes.
5. Reviewing and refining themes.
6. Defining and naming themes.
7. Producing the written report outlining the themes and final analysis.

During the process, discussions were held amongst the research team to resolve any discrepancies. The graph was generated by SigmaPlot (Version 15).

Ethical Considerations

Respondents were asked to consent to their participation in the study following an explanation by the researcher. The responses of the focus groups and key informant interview were recorded after getting consent of the respondents. Written and recorded responses were safely stored, only accessible to the research team. Respondents were not asked for identifiable personal information, but responses were anonymized at the point of analysis.

Rigour

The integrity of the supplementary analysis was promoted in two ways. The analysis included the perspectives of multiple groups of respondents, including project group leaders and other learners who were not group leaders as well as reviewing learners' project reports. The coded data was checked by multiple researchers.

3. Results

3.1 Products made by learners in NFT projects in Uganda

Leaners made a variety of products that were divided into five broad categories which included more healthy food products, less healthy food products; post-harvest handling equipment; nutrition education materials; sanitation and environmental hygiene materials as well as skin care products as described in sections 4.2.3.1, 4.2.3.2 and 4.2.3.3.

3.1.1 Less healthy food products

Out of 397 learners, 93.5% of them (371) made at least a product that was grouped as a less healthy food products due to several reasons that were derived from analysis of the students' recipes. These are summarized in the Table below 1.

Table 1: Less healthy food products made by the learners

Food products	Reasons for grouping them less healthy
Tropical jam; pawpaw jam; pineapple jam; apple jam; mango jam; caramel Sugar, milk shake, hibiscus wine, lemon wine, pineapple wine, simsim balls, black tea, African tea, English tea, Marmalade, pineapple juice, Apple Chutney, Mango Chutney	Have a lot of added sugar and linked to obesity, diabetes, hypertension, stroke and myocardial infarction
Plain scones; biscuits; cookies; Bread; French slices; rocky buns, daddies and cakes,	Have added sugar; refined wheat and margarine and linked to obesity, diabetes, hypertension, stroke and myocardial infarction
Tomato Sauce	Due to destruction of labile vitamins; there is added salt linked to hypertension.
Pizza	Have refined wheat, cheese and much salt and linked to obesity, diabetes, hypertension, stroke and myocardial infarction
Chips, Omelette, crunches, Banana Crisps	Deep frying and linked to obesity, diabetes, hypertension, stroke and myocardial infarction
Meat balls	Ground meat due to link to cancer development and deep frying and linked to obesity, diabetes, hypertension, stroke and myocardial infarction
Kebabs	Roasting that yields Polycyclic Aromatic Hydrocarbons (PAHs) that cause cancer.
Popcorn	High fat and added salt and linked to obesity, diabetes, hypertension, stroke and myocardial infarction
Samosa	Have refined wheat and are deep fried hence linked to obesity, diabetes, hypertension, stroke and myocardial infarction
Cream	High fat and linked to obesity, diabetes, hypertension, stroke and myocardial infarction

3.1.2 More healthy food products

Healthy food products included those made from fish, plant-based foods, refined wheat substitutes, with no added sugar and those having probiotics. These were made by 60.9% (242) of the learners and they included orange smoothies; Banana smoothies; salads; pickles, Matooke powder enriched with *Mukene (Rastreneobolus agentus);* stuffed egg; Sugar free organic juice; soya powder and beverages; Mukene powder; Carrot Juice; Yoghurt; Pumpkin Chapati; Sweet Potato *Mada*zi; Sweet potato biscuits; Cocoa; yam biscuits; yam balls; Bean balls; Popcorns; Avocado Chapati; yam balls; Avocado Smoothie; Mango Squash; Orange Squash; pineapple juice; Millet porridge; pilau mixed spice; mixed vegetable powder, homemade chocolate, tomato powder, fiber and nutrient enriched Spaghetti; Groundnuts; Mango and avocado leaf powder; pea powder, Dried ginger, powdered carrots; powdered chili pepper and Garlic; tea spices; Turmeric powder; Dried rosemary; Bean porridge; Carrot juice; cassava flour biscuits soy fish powder and Spinach powder.

3.1.3 Others

These included post-harvest food handling equipment like wall hangings; food carriers; charcoal cooler; solar drier and packing equipment that were made by 11% (44) of the learners. Also, Nutrition Education materials like fruit book; malnutrition magazine, videos and kitchen plans that were as well made by 9% (36) of the learners. In addition to that, there were kitchen equipment that included oven gloves, clay potted saucepan, blenders, charcoal stoves and local oven which were made by 2.8% (11) of the learners. Then sanitation and environmental hygiene materials like door mats, charcoal briquettes, table mats, wall hanging, motifs, renewable sanitary pads, tampons and refuse bin were made by 18.6% (74) of the learners. A skin care product (cream) was made by 2.0 % (8) of the learners; water safety equipment (water purifier) was made by 1.3% (5) of the learners while first aid education materials (information sheets) were made by only 0.5 % (2) of the learners. The relative frequency of each category of products is summarized in fig 2 which shows that almost all learners are making less healthy food products and only slightly greater than half of the learners are making more healthy food products. The least represented category of products are nutrition education materials, post-harvest food handling equipment, Sanitation and hygiene products, kitchen equipment, skin care products, water safety equipment and first aid education materials respectively.

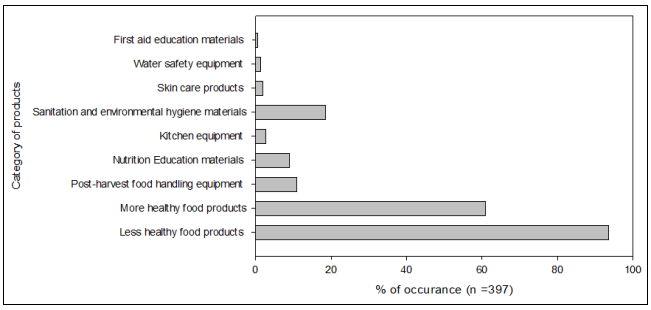

Fig 2: Relative frequency of each category of products made by learners

3.2 Reason (s) for learners' choice of ingredients in NFT projects

Table 2 shows that the majority of the learners gave reasons

to ensure high sensory appeal of the product as well as other non-sensory appealing product formation reasons. The least given reasons were those on nutritional quality of the ingredients as well as increasing shelf life. Further analysis shows that some reasons on nutritional quality of the ingredients (e.g., fruits have fiber that are good in body building; Lemon juice because it is a citrus fruit which resist diseases and infection) were wrong.

Table 2: Reasons given by learners for the choice of ingredients

Category	Reasons	Number of reasons per category	% of learners who gave th answers (n = 284)
Increasing shelf life	Baking powder to keep product for long, Lemon leaves to act as a preservative; High sugar does not allow bacteria, yeast, and Mold to grow and spoil the Jam, Orange peels were used as the acid to preserve the jam from going bad, vinegar is used as a preservative to pickle vegetables, to denature enzymes that spoil fruit products, they were durable, used sugar as a preservative	8	4.57
Sensory appeal	Used sugar to make cakes sweet and tasty; used eggs to make cakes come out properly; flour was to bind the ingredients in order for the cake to come out; butter to make product soft; Flavours to give product nice taste and smell; Blue band to make product soft; Baking powder to make product big, Vanilla for flavouring and smelling nice, Pineapple were used to obtain flavour, Cocoa powder helps in changing colour and also provide nice smell; yeast make dough rise; wanted to make delicious meals, salt to make it tasty; chocolate to give the cake flavour; cheese to help make the pizza stretchy; To make the product attractive; Milk to soften the cakes; onions to make pizza delicious; jam to make buns more tasty; milk to have a milky smell; Sugar to help us compact the simsim together and add sweetness; Mango juice to produce a tasty drink; Cream makes the milk shake sweet; Acid helps pectin to set into a firm gel; Acid gives a better flavour as it overcomes the sweetness of the sugar; Ginger to produce a good scent; Pectin in making fruit jam to form gel structure which makes jam firm, turmeric powder to solve the problem of poor appetite, tendering the products, to produce tasty drink	31	24.65
Reasons for successful production process	Water is used for mixing products; water to mix dough; oil for cooking the product; flour is the main ingredient in the product; To make the product of good quality; A cloth is soft and does not cause discomfort; Polyethene piece of paper does not allow blood to pass through; Needle is used for sewing piece of cloth; Pineapple pulp to make enough juice; Pineapple peelings to add more pectin in jam; Used syrup because its a mixture of sugar and water in various concentration; Acid reacts with some of the sugar so it will not crystalize when jam sets; While making yoghurt starter culture ferments lactose to form lactic acid which decreases PH and cause milk to clot; Used cotton and sponge because they were cheap; Lemon juice lowers PH of the jam mixture and neutralizes the negative changes in the strands of pectin, Used cement to make it hard and not to break easily, Used glue to stick the card in place, Used small stones to avoid any small particles from escaping.	19	33.80
Nutritional quality	Butter contains fats that give the body energy; fruits have fibre that are good in body building; Flours contain starch; For getting some nutrients in the body; Lemon juice because it is a citrus fruit which resist diseases and infection; Milk has fat soluble vitamins like ADEK; Carrots provide vitamin A, Silver fish was to add high value protein content in the product, Soy fish contains vitamins that help to prevent malnutrition, milk contains proteins. Pumpkin seeds, Carrots and ground nuts to add nutritive values. Spinach powder, cassava, rice powder and wheat flour contain carbohydrates"	12	16.00
Convenience	They are easy to use, easily accessible or available, cheap to buy, carrots can easily be dried, faster in cooking or preparation.	5	20.8

4. Discussion

The majority of the products made by secondary school NFT learners being unhealthy food products unveils a significant concern given the global prevalence of overnutrition, characterized by increasing rates of overweight and obesity. This is because several items in this category contain excessive amounts of added sugar, refined wheat, margarine, and high salt content which are well-known contributors to the rising rates of overnutrition, obesity, and diet-related non-communicable diseases (D'Innocenzo *et al*., 2019; Pramono *et al*., 2023) [11, 46]. In addition to that, the inclusion of deep-fried items like chips and kebabs, further amplifies the concerns surrounding these secondary school food product choices because deep-frying not only adds excess saturated fats (Oke *et al*., 2018) [39] but also exposes individuals to acrylamide, a potentially carcinogenic substance formed during the cooking process (Ahmad *et al*., 2022) [1]. This dual assault on health is a matter of grave significance, warranting proactive measures to address this considering that these products may be consumed not only by the learners themselves but also by others in the school community, including staff and can ripple out to their families and neighboring communities to these schools. The products that were categorized as unhealthy can be made healthier in the following ways;

While making jam, wine and milk shakes learners can use natural sweetness of fruits, or consider using sugar substitutes like stevia or monk fruit instead of added (Mohan & Singh, 2020) [33]. Also, while making plain scones, pizza, biscuits, cookies, bread and cakes, they can replace refined wheat flour with whole wheat flour to increase fiber content (Hughes *et al*., 2020) [24]. Instead of adding sugar in the respective wheat products, learners can use natural sweeteners like honey or maple syrup (Mohan & Singh, 2020) [33]. Furthermore instead of using Margarine, they can use healthier oils like olive oil or coconut oil (Khaw *et al*.,

2018) [25]. For pizza toppings, load up colorful and nutrient-rich vegetables like bell peppers, tomatoes, mushrooms, spinach, and onions to add vitamins, minerals, and fiber to your pizza without contributing excessive calories or unhealthy fats (Clark, 2019) [10]. Finally, use herbs and spices like garlic, and red pepper flakes to add depth to the taste without relying on excessive salt (Taladrid *et al*., 2020) [51].

For teas, added sugar can be avoided by adding spices like ginger, cinnamon to create taste and promotion of herbal teas that don't require added sugars for flavour (Helilusiatiningsih, 2023) [23]. Learners should also be encouraged to dilute fruit juices with water to reduce sugar concentration and encourage whole fruit consumption instead of fruit juices to benefit from fiber and nutrients (Guasch-Ferré & Hu, 2019) [19].

To make healthier chips, instead of deep-frying, bake or air-fry chips to reduce the amount of oil and lower the overall calorie content (Mittu *et al*., 2023) [32]. Also use sweet potatoes or a variety of vegetables to make chips to provide more nutrients and fiber compared to traditional Irish potato chips (Truong *et al*., 2018) [52]. For Omelette, add a variety of vegetables such as spinach, tomatoes, bell peppers, and mushrooms to increase fiber and micronutrient content (Butt & Sultan, 2018) [9] and healthier fats like olive oil or avocado oil for cooking to reduce saturated fat content (Guasch-Ferré *et al*., 2020) [20]. For crunches, use whole wheat for added fiber (Barrett *et al*., 2020) [3] and opt for baking or roasting instead of deep-frying to reduce oil and overall calorie content (Bouchon & Dueik, 2018) [7]. For Banana crisps, make them by dehydrating or baking slices of banana instead of deep-frying so as to maintain the natural sweetness of bananas without increasing the caloric content (Uma *et al*., 2022) [54].

For healthier meatballs, learners can use lean ground meats, such as turkey, chicken, or lean cuts of beef to reduce the saturated fat content (Kim *et al*., 2017) [26], instead of deep-frying, bake or grill meatballs to reduce the amount of added fats and calories associated with deep frying (Mittu *et al*., 2023) [32]. Furthermore, use whole wheat breadcrumbs or alternative binders like oats to add fiber and nutrients to the meatballs and hence contribute to a healthier overall nutritional profile (Balestra *et al*., 2019) [2]. Also, mix finely chopped vegetables such as onions, garlic, carrots, or spinach into the meat mixture to not only adds nutrients but also helps to retain moisture, allowing for less reliance on added fats (Drummond & Brefere, 2021) [14]. Finally flavor the meatballs with herbs and spices rather than excessive salt to reduce sodium intake (McKenzie *et al*., 2022) [30].

Healthier kebabs can be produced through reducing the potential formation of Polycyclic Aromatic Hydrocarbons (PAHs) during roasting. So, learners can grill instead of roasting as it can reduce the production of PAHs (Das *et al*., 2023) [12]. They can also, marinate the meat before cooking, as this has been shown to reduce the formation of PAHs (Vişan *et al*., 2021) [55]. Ingredients like vinegar, citrus juices, and herbs can be used in marinades to add flavor and create a protective barrier during cooking (Vişan *et al*., 2021) [55]. Also, they should opt for lean meats, such as chicken, turkey, or lean cuts of beef, to reduce the fat content hence making healthier kebabs and also minimize the potential for fat drippings to cause flare-ups during cooking (Duedahl-Olesen & Ionas, 2022) [15]. They can also increase the nutritional content of kebabs by adding a variety of colorful vegetables like bell peppers, cherry tomatoes, onions, and zucchini. Vegetables not only provide essential nutrients but also contribute to the overall flavor and texture of the kebabs. Also, they can consider partially cooking the meat before grilling to reduce the time it spends over high heat hence minimizing the formation of PAHs while still achieving a flavorful result on the grill (Duedahl-Olesen & Ionas, 2022) [15]. Finally, learners can use flavorful herbs and spices to enhance the taste of kebabs without relying on excessive salt (McKenzie *et al*., 2022) [30].

To make popcorn healthier and reduce the potential negative health impacts associated with high fat and added salt, they can use an air popper to make popcorn without added fats because air-popped popcorn can be a low-calorie, high-fiber snack (Pflugradt, 2021) [44]. Finally, instead of adding excessive salt, they can flavor popcorn with herbs and spices like nutritional yeast, garlic powder, cayenne pepper (Robertson, 2020) [49].

To make healthier samosas use whole wheat flour for the dough to provide more fiber and nutrients compared to refined wheat hence promoting better digestion and overall health (Hughes *et al*., 2020) [24]. Instead of deep-frying, bake or air-fry the samosas to significantly reduce the amount of oil absorbed during cooking, making the samosas lower in saturated fats and overall calories (Mittu *et al*., 2023) [32]. Also, incorporate lean proteins like chicken, turkey, or legumes as part of the filling to reduce saturated fat content associated with beef (Kim *et al*., 2017) [26]. Furthermore, increase the vegetable content in the filling, using a variety of colorful and nutrient-rich options such as peas, carrots, spinach, and potatoes (Butt & Sultan, 2018) [9].

Finally, cream is often high in saturated fat and can indeed contribute to health issues such as obesity, diabetes, hypertension, stroke, and myocardial infarction when consumed excessively. To make healthier cream, learners can consider using plant-based cream alternatives such as almond milk, coconut milk, or soy milk because these options often contain less saturated fat compared to traditional dairy cream (Paul *et al*., 2020) [43]. They can also substitute part or all of the cream with cottage cheese since this alternative provides protein and nutrients with less saturated fat (Clark, 2019) [10]. Also, instead of relying solely on the richness of cream for flavor, use herbs, spices, and other seasonings to enhance taste so as to reduce the amount of cream used while maintaining the overall flavor profile (Granato *et al*., 2018) [18].

It is important for secondary school NFT projects to yield healthier food products because according to the World Health Organization (WHO), over 1.9 billion adults were overweight in 2016, with over 650 million of them classified as obese (Gupta & Garg, 2020) [21]. These alarming statistics already place a substantial burden on healthcare systems and are linked to a host of serious health conditions, including heart disease, diabetes, and certain types of cancer (Li *et al*., 2020) [28]. If learners continue to produce and consume such unhealthy products, and the products find their way into the general population, it is anticipated that the prevalence of over nutrition will continue to rise at an alarming rate (Blüher, 2019; Popkin & Ng, 2022) [6, 45]. Predictive models indicate that, by 2050, the global prevalence of overweight and obesity could affect an estimated 3.3 billion people (Okunogbe *et al*., 2021) [40] marking a staggering increase in the incidence of diet-related health issues. This estimate is based on the normal production rate of the foods labeled

"unhealthy" where only food industries have majorly been involved in food production. With the promotion of such unhealthy foods' production in secondary schools under the curriculum of Food Technology and Nutrition, there will be over production of unhealthy foods resulting to their surge in the market and therefore overconsumption by the population yielding a much higher global prevalence of overweight and obesity by 2050. This underscores the critical importance of shifting away from the production and consumption of unhealthy foods, especially within educational settings, to avert the impending public health crisis.

In addition to that, learners gave reasons for their choices of ingredients when creating products in NFT. This gave a critical insight into their developing thought processes (Rahnuma, 2020) [47]. The dominance of sensory appeal as a reason reflects the significance of taste and presentation in learners' food product development (Haase *et al*., 2020) [22]. This focus on sensory qualities is entirely logical, as it plays a pivotal role in shaping consumer preferences and the desirability of their products (Biswas *et al*., 2021; Schifferstein *et al*., 2021) [5, 50].

However, it is crucial to note that while sensory appeal is paramount, it should not compromise fostering a culture of health consciousness among the learners (Delia & Krasny, 2018) [13]. For the Nutrition and Food Technology projects done in Uganda, nutritional quality received less attention while selecting ingredients for making the products. Nutritional quality should be a fundamental consideration in ingredient selection, particularly in a school context where the goal is to educate learners about making informed dietary choices. Some learners, even demonstrated misconceptions regarding the nutritional quality of ingredients. For instance, attributing fiber in fruits to bodybuilding and citing lemon juice as a disease-resistant citrus fruit are examples of incorrect beliefs that need correction. To mitigate the risks associated with unhealthy food products, it is imperative to enhance learners' nutrition literacy (Duong *et al*., 2020) [16]. This includes providing a better understanding of rationales for ingredient selection, portion control, and the implications of various food choices on health. A comprehensive approach to nutrition education should encompass not only the art of making food products but also the science of nutrition. In essence, schools should serve as catalysts for improved public health, helping to reduce the societal burden of diet-related health conditions.

5. Recommendations

During project-based learning of Nutrition and Food Technology in schools, there is a compelling need to shift the focus of project-based learning towards of the production of healthier food products. Also, the relationship between learners' choice of ingredients and the risk of over nutrition and related conditions should not be understated. This is because as future members of society, these learners play a pivotal role in shaping the dietary landscape and their learning experiences have a profound impact on their future dietary choices, as well as the choices of those they influence, including their families and peers. To aid teachers in effective delivery of health driven food product development in secondary schools, resources to support them to incorporate knowledge of healthy nutrition classroom projects should be developed. These should be aligned to contain sound nutritional principles such as reducing added sugars, refined grains, and excessive salt in food products as well as address common misconceptions related to ingredient choices. Furthermore, teachers of Nutrition and Food Technology should be given access to some of the mainstream nutritionist, dietitians and food scientist professional development programs to stay informed about the latest research and dietary guidelines that encompasses the science behind the ingredients used in food preparation, processing and production.

6. Conclusion

This study has shown that secondary school Nutrition and Food Technology learners in Uganda are majorly acquiring training and skills in food production that are highly leaning to using the technology of value addition to produce unhealthy food products.

7. Limitations of the study

Nutrition and Food Technology in secondary schools in Uganda is an optional subject offered by a few schools of which half of NFT offering schools are in Kampala, the capital city of Uganda. Hence, this study was only carried out in Kampala. So, generalizing findings to other parts of the country and yet data was not picked from there might be misleading. Never the less, the study highlighted how project-based learning in Nutrition and Food Technology is contributing to combating overweight, Obesity and associated Non-Communicable Diseases.

8. Funding

The authors acknowledge and appreciate the financial support as well as institutional support of NORHED, Makerere University, University of Agder, and the TELLS project. The funders did not influence the study.

9. Data Availability Statement

The dataset used to produce the results in this study are available upon request to the corresponding author.

10. Declaration of Interest Statement

The authors declare that they have no conflict of interest.

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