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Knowledge And Awareness Of Food Adulterants And Its Health Implications On Consumers

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Abstract

Food adulteration is a huge societal issue. Adulteration of food items has been common in Ghana, particularly in products marketed in cities and towns, where innocent consumers are duped owing to sub-standards/poor quality of food products, posing a severe health concern. The study aimed to assess knowledge and awareness of food adulterants and their health implications on consumers. A cross-sectional research design was used to collect the data from customers in the Kumasi Metropolis. Customers who frequent any of the catering establishments made up the study demographic. The study targeted a sample size of 400 respondents which included 100 restaurant owners, 50 food vendors, 150 chop bar owners, and 100 food, joint operators, using a multi-cluster sampling approach. The data were gathered through the use of a questionnaire. Cronbach's alpha was used to assess the reliability (internal consistency) of the components that made up each construct. Experts in the industry of catering and hospitality were contacted to assess the questionnaire's validity. The data were descriptively analysed in frequencies and percentages. The study revealed that about 90% of the respondents identified roasted corn, ground roasted barley, sawdust, plants roots, colour, and sugar as substances often used to adulterate food products in Ghana. It was concluded that consumers had average knowledge about the health implication of food adulteration and a small section of food providers and consumers knew that continuous consumption of adulterated food could result in health problems. It was recommended to the Public Health Directorate of the Ghana Health Service to have a policy those resource health facilities across the country with a relevant document on food adulteration that can be freely given to the local people.

Keywords: Food adulterant, consumer awareness, food adulteration knowledge, health implications, chops bar operators

Introduction

When it comes to preventing food adulteration in a country, customer behaviour is crucial. The nature and outlook of the market influence consumer purchase behaviour and it provides a sensible approach of organising the vast amount of information concerning aspects influencing purchasing habits [1, 2]. Purchasing techniques include the buyer deciding on the type, price, and amount of things to be purchased through market agencies [3]. Customers are confronted with a larger range of purchasing situations than in the past; as a result, there has been and will continue to be, an increase in the number of consumer complaints and difficulties, particularly with

consumer rights and regulation [4, 5, 6]. Fraud exploitation and misrepresentation practitioners have more opportunities thanks to technological advancements. As a result, knowledge, and awareness of the risks of food adulteration, as well as the relevant regulations and the consumers, are critical [6, 7].

Food adulteration poses various forms of health risks and hazards to the consumer and society as a whole. For instance, consuming oils that have been adulterated with argemone oil, mineral oil, Karanja or castor oil has been found to result in loss of eyesight, damage to the liver, heart problems, stomach infections, or lead to cancer [8]. Other works have found mustard oil which is often adulterated with argemone oil and butter yellow to cause the consumer gall bladder cancer and even cause a consumer epidemic of dropsy, glaucoma, and loss of eyesight [9, 10]. This suggests that food adulteration though may bring economic gains to the producer or culprit but will impact negatively on consumer health. On this premise, this section of the work seeks to explore consumer level of awareness and knowledge on the effect of food adulteration on their health and general wellbeing.

A study done by Hossain [11] assessed consumers' level of awareness towards food adulteration in the city of Dhaka Bangladesh and concluded that most of the respondents surveyed in the study had adequate knowledge on the potential health defects they a consumer will suffer from if they consumed adulterated foods. Specifically, the respondents identified health risks such as acute and chronic diseases as some of the health ramifications associated with the consumption of adulterated foods. Also, Aleksandra's [12] work sought to assess students' understanding of food adulteration and food fraud and their implications for consumers and producers (processors and/or farmers). With the theoretical section of the work, the cognitive critical analysis of the world's literature was used whereas on the empirical part, a questionnaire survey was conducted among students of the Economics Faculty at Polish university in 2016. Results from the study showed that 35.4% of the respondents agreed that consuming adulterated foods could adversely affect their health most especially for consumers with allergic disorders. Moreover, with regards to their understanding of food adulteration, it was revealed that most of the respondents knew what food adulteration as 30-40% of the respondents described it as the practice where food producers lower their costs of production (e.g. by substitution) to make higher profits. However, the rest of the respondents, regard food adulteration as the practice whereby a food producer replaces his or her food ingredients with lower quality substitutes causing a difference in taste and nutritional value.

Similarly, in a study done by [13], it was established that consumers were very much aware of the incidence of food adulteration in the market as well as the related consequence its occurrence could have on consumers' health. For instance, they observed that most of the consumers were well aware that the various chemicals and colors used in fruits and vegetables could be very poisonous to the consumer. Specifically, most of the consumers were able to list chemicals such as calcium carbide as the most frequently used chemical to speed up mango and bananas ripening, copper sulphate as the most used to ripen fruits faster, oxytocin a hormone used for faster growth of pumpkin, watermelon, brinjal, gourds, cucumber. Also, some of the consumers were found to be much aware of the cheap green colors containing chemicals such as metallic lead applied to bitter gourd and leafy vegetables to give fresh color. According to Anita and Neetu [13], most of the respondents agreed that eating foods or vegetables that have been contaminated with these chemicals can cause consumer nausea and diarrhea, particularly among children.

Anita and Neetu's [13] findings are comparable to that of [14] and [15] as in their respective studies, it was observed that most consumers had a strong perception that consuming foods that have been contaminated chemically or naturally can result in health implications such as diarrhea, abdominal pain, nausea, vomiting,

eyesight problem, headache, cancer, anemia, insomnia, muscular paralysis, and brain damage, stomach disorder giddiness, joint pain, liver disorder, dropsy, gastrointestinal problems, respiratory distress, edema, cardiac arrest, glaucoma carcinogenic effects, kidney failure, digestive system disorders, etc. Additionally, in another study done by [16] in South India, it was found that a majority of subjects (52.5%) were aware of food adulteration and its associated effect on consumer health. However around 38.3 percent did not know anything about food adulteration, the foods that are often adulterated and the contaminants often used as well as its associated implications on their health. More so, a study done by [17] which sought to explore consumers awareness about food adulteration occurrence in the Dhaka city of Bangladesh concluded that even though, food adulteration has received considerable attention in the country's media nevertheless, most of the respondents in the study still lacked adequate knowledge on what comprises food adulteration, the commonly adulterated food items, and the adulterants used. For instance, the study observed that most of the respondents thought that food adulteration has decreased merely because of the increase in mobile court raids in the country. The study concluded that even though the respondents had a general awareness about food adulteration but lacked sufficient knowledge on what constituted food adulteration, commonly adulterated food items in their market, and the adulterants often used by producers. Gautam and Singh [18] confirmed similar results in their study as their work observed that majority of the respondents in their study had lower awareness scores about adulteration in food items as well as the damaging effect it can have on a person's body.

Surprisingly, in the case of Ghana, the only study that comes to notice is the work of [19] which primarily sought to assess consumers' awareness of food adulteration by randomly selecting one hundred (100) respondents within the Bolgatanga Metropolitan as their study sample. Even though this study has in a way looked into consumers' awareness of food adulteration in the Ghanaian context nevertheless, it has to be pointed out that merely selecting 100 individuals randomly within Bolgatanga Township may not be exhaustive to expose all Ghanaians consumers' level of awareness towards food adulteration. Hence, more studies will be required to add more breadth to the literature by undertaking the study within different regions or contexts to explore consumer level of awareness and understanding towards food adulteration. Accordingly, it is against this background that this study seeks to assess the knowledge and awareness of food adulterants and their health implications on consumers within the Ashanti Region of Ghana.

Literature Review

In the study of [20], coffee products were identified as one of the frequently adulterated food products in the food and beverage industry. For instance, their study observed that ground coffee may be cut with other ground and roasted plant materials to increase its quantity and reduce its production cost. In the Southern part of Ethiopia, a study done by [21] observed that in an attempt for coffee makers to make coffee appear bulky and colourful, chicory, roasted barley powder, and tamarind seeds were added to coffee products.

Other food spices such as ground black pepper, vanilla extract, turmeric, star anise, paprika, and chili powder are some of the culinary spices that are prone to food adulteration [22]. Specifically, Black et al. [22] observed that adulterants such as dyes are often used to colour paprika, chili powders, and curries. More so, with other products like honey, adulterants such as molasses, cane sugar, other natural sweeteners were added to it to increase its volume [23]. According to Galvin-et al., [24], papaya seeds have been used to adulterate and bulk black pepper. Lawton [25] observed that using papaya seeds to adulterate black pepper can become very deadly to the human body as it can cause consumers liver and stomach problems, and can become a major source of

health risk to the consumers. Nallappan, et al., [26] observed in their study that yellow chalk powder was frequently added to turmeric to make it look bulky and heavier to the consumer. This adulterated product however can cause swelling of the face, loss of appetite, nausea, and vomiting [26]. Another food product that is often adulterated is cooking oil. For instance, olive oil is often adulterated with a lower-cost substitute, such as olive oil from a different origin or any other type of oil [27]. In a study done by [28] in Kolkata, India it was revealed that adulterants such as argemone oil, mineral oil, Karanja Oil, and cyanide were often used to contaminate both packages and unpackaged soyabean oil and mustard oil.

The increasing demand for milk both in homes and catering facilities has contributed to the increasing rate of milk adults by milk producers. Oftentimes, milk adulteration constitutes the practice of adding water to milk or removing the beneficial fats from milk. In certain times, soya milk starch, groundnut milk, and wheat flour are added to milk to increase its quantity [29]. Others too tend to add another chemical such as urea, starch, flour, cane sugar, vegetable oils, and detergents to either promote the level of some essential nutrients in the milk after the reduction of a given amount and/or to mislead the consumers to increase their profit margin [14]. Also, other preservatives like formalin and some antibiotics are added to milk to increase its shelf life [30]. This addition of substances decreases the nutritional value of milk and even poses a major health risk to the consumer or user [31]. In certain instances, milk adulteration could be caused by unintentional acts such as bacteria, yeast, fungi and dust contamination, water, animal hair due to livestock keepers' unhygienic milking, handling, and storage practices [32]. According to Asrat and Ermias [33], food grain adulteration constitute the practice whereby sand or crushed stones are added to food grains to increase their weight. In other practices, cereal grains and pulses are mixed with plastic beads that resemble grains in colour and size.

In using the United States Pharmacopeia Convention (USP) global database as their study data source, the study of [34] analyzed the reported cases in the database to ascertain the kinds of food ingredients that are very susceptible to global food fraud. Results from the analysis showed that foods substances such as olive oil, milk, honey, saffron, orange juice, and coffee were found to be the most common targets for adulteration. In all, milk adulterations contributed 14% of all records from 1980 to 2010 and also identified as the second highest adulterated food substance, after olive oil which scores 16% [34, 35, 36]. Also, oil total cases of adulteration stood at 24%, milk at 14%, and spices at 11% [37]. Renee [38] corroborated similar food ingredients in their study as their results identified food substances such as honey, meat, milk, grain-based foods, fruit juices, organic foods, coffee, and some highly processed foods as highly adulterated food substances.

According to Tola [39], olive oil has become one of the major targets for food adulteration. Usually, olive oil may be replaced with a lower-cost substitute, whether it is regular olive oil instead of higher-priced extra virgin olive oil or a less expensive variety from Greece or Turkey, instead of from Italy as the label claims. In certain times too, an alternative seed or nut oil may be sold as or thinned out with hazelnut, soybean, corn, peanut, sunflower, safflower, walnut, vegetable, canola, or palm oil, and lard [39]. This practice is not only bad but could be very deadly to consumers who have allergies to certain food substances such as nut or legume oils [40]. Olive oil diluted with hazelnut oil is a common form of economically motivated adulteration [41]. More so, fruit juice has been found as one of the commonest targets of beverage adulteration. Often extra water may be added to juice to water it down or in other instances, a more expensive juice such as the ones from the pomegranates or other "super" fruit might be cut with a cheaper juice such as apple or grape juice [39]. Some juice may be only water, dye, and sugary flavorings, although fruit is the listed ingredient on the label. Orange juice has been shown

to sometimes contain added unlisted lemon juice, mandarin juice, grapefruit juice, high fructose corn syrup, paprika extract, and beet sugar. Apple juice has been shown to have added unlisted grape juice, high fructose corn syrup, pear juice, pineapple juice, raisin sweetener, fig juice, fructose, and malic acid [42].

Again, when it comes to honey, adulterants such as sugar syrup, corn syrup, fructose, glucose, high-fructose corn syrup, and beet sugar are often added to it to make it thicker without being disclosed on the label [43]. Additionally, honey coming from an unauthentic region such as the phenomenon where honey from China is transshipped through another route and falsely sold as honey from the second country usually to avoid higher customs duties and tariffs that would be imposed on honey from China [43]. Lastly, a 2012 report on food fraud in US restaurants and retail outlets observed that 58% of the eighty-one retail outlets sampled, sold mislabeled fish with small markets having a higher incidence of fraud (40%) than national chain grocery stores (12%). Furthermore, all of the sushi bars (n=16) tested sold mislabeled fish and 94% of the “white tuna” tested was not tuna at all [44].

Materials and Methods

A cross-sectional research design was used to collect the data from customers’ in the Kumasi Metropolis to determine their knowledge and awareness of food adulterants and their health implications on consumers within the Ashanti Region of Ghana. The cross-sectional design proved to be the most effective method for achieving this goal. Customers who frequent any of the Kumasi Metropolis' catering establishments made up the study demographic. The foodservice sector is divided into local and continental restaurants, food vendors, chop bars, and one corner shop, according to the Ghana Tourism Authority [45]. Restaurant owners were targeted for 100 customers, food vendors for 50, chop bar owners for 150, and one corner store food joint for 100 customers. The study's population consisted of 400 customers and food service providers. This study employed a multi-cluster sampling approach. The population was first classified into consumer categories using the multi-cluster sample method, which included restaurants, food vendors, chop bars, and one-corner dining establishments. However, Cochran's sample size formula for continuous data was used to calculate the sample size for each detected cluster, as cited in [46]. As a result, the determined sample size for Restaurants is 79, with an estimated alpha value of 0.01, a t-test value of 2.58, and a margin error of 0.03. The data were gathered through the use of a questionnaire. Nasreen & Ahmed [17], [28] and [47] measuring scales were used to measure respondents' knowledge and awareness of food adulterants and their health implications. Experts in the industry of catering and hospitality were contacted to assess the questionnaire's validity. Cronbach's alpha was also used to assess the reliability (internal consistency) of the components that made up each construct. To determine the dependability of each measuring scale, a Cronbach’s Alpha value of 0.70 or higher was utilized as a criterion. The data was entered into IBM Statistical Package for Social Sciences (SPSS) version 20.0, and descriptive statistics were used to analyze the results. Descriptive statistics were used to analyze the data (i.e., frequencies, percentages).

Results and Discussion

Demographic Profile of Customers

Table 1 shows the demographic profile of the customers of the respective foodservice companies. Clients were surveyed using a total of 310 questionnaires delivered to customers of various foodservice businesses. A total of 285 questionnaires were received, 40 of which were unsuitable due to their incompleteness, and the remaining 245 were used for the study, yielding an 85.9% response rate. According to Babbie [48], a response rate of more

than 85% indicates that the received questionnaire is sufficient for the study's analysis. In Table 1, the demographic profile of the surveyed clients of the selected foodservice providers revealed that 165 (67.3%) were males and 80 (32.7%) were females. This indicates that the majority of the clients were men, validating the long-held belief that men are more prone than women to eat their meals away from home. Furthermore, when it came to the respondents' ages, 15(6.1%) of the respondents were 50 years or older. On the other hand, 155 (63.3%) of the respondents were between the ages of 21 and 50, while 55 (22.4%) of the respondents were between the ages of 41 and 50. In terms of the catering facility where the respondents got their food during the study, it was discovered that 30 (12.2%) of the respondents got their food from restaurants, 50 (20.4%) from food chop bar operators, and 75 % (75%) from food chop bar operators (30.6 %) took their meals from food vendors, 35(14.3%) had their meal at corner shop food joints and the rest that is 55(22.4%) had their meals at other food joints.

Table 3 shows that 45(18.4%) of the respondents had no formal educational qualification, 50(20.4%) had their education up to the basic level, 40(16.3%) had their educational qualification up to the secondary level, 15(6.1%) of the respondents had National Vocational Training Certificate and diploma/HND as their highest form of qualification, and 65(20.4%) had their education up to the secondary level. In terms of whether the respondents had been diagnosed with any chronic ailments, the study's findings indicate that more than half of the respondents (190, or 77.6%) had no such history. In contrast, 2 (10.2%) of the respondents had a chronic illness, and 30 (12.2%) of the respondents were unsure whether they had a chronic illness or not. Furthermore, when asked if the respondents were on any special diet, Table 1 shows that the bulk of the respondents, 220 (89.8%), were not. In comparison, only 15 % of respondents (6.1 %) were on a special diet, with the remaining 10 % (4.1 %) having no idea whether they were on one or not.

Table 1: Demographic Profile of Customers

Demographic variable	Category	Frequency	Percentage
Gender	Male	165	67.3
	Female	80	32.7
	Total	**245**	**100%**
Where they patronize their food from	Restaurant	30	12.2
	Food vendors	50	20.4
	Chop bar operators	75	30.6
	one corner shop eating places	35	14.3
	Others	55	22.4
	Total	**245**	**100%**
Educational qualification	No formal education	45	18.4
	Basic education	50	20.4
	Secondary	40	16.3

	education		
	National vocational Training certificate	15	6.1
	Diploma/HND	15	6.1
	Bachelor's degree	65	26.5
	Master's degree	5	2.0
	Total	**245**	**100%**
Diagnosed of any chronic ailment (i.e. diabetes, high blood pressure, cancer, etc.)	Yes	25	10.2
	No	190	77.6
	Am not aware	30	12.2
On special diet	Yes	15	6.1
	No	220	89.8
	Am not aware	10	4.1

Commonest Forms of Culinary Spices Adulterants

This item sought to establish from the respondents the adulterants often used to contaminate culinary spices in the Ghanaian market. Accordingly, the respondent's responses on the substances often used to adulterate culinary spices have been presented in Table 2. Results from Table 2 suggest that most of the respondents thus, 168(39.1%) had no idea on the kinds of adulterants often used to contaminate culinary spices in the Ghanaian market. Meaning, they were not able to identify any of the common sources of ingredients used by the market women in adulterating culinary spices. However, to 19.8% of the respondents ground black pepper was the common source of material used in adulterating culinary spices. Also, 17.5% of the respondent's chili powder constituted the common ingredient often used to adulterate culinary spices in most Ghanaian markets. Again, 10.5% of the respondents identified turmeric as the common source of additive used in adulterating culinary spices in most Ghanaian markets. Also, 8.4% of the respondents identified paprika whereas 4.7% of the respondents identified sawdust as the additives often used to contaminate culinary spices. What this result suggests is that nearly 40% of the respondents had no idea on the kind of items often used by the market women to adulterate culinary spices.

Table 2: Commonest Forms of Culinary Spices Adulterants

Culinary spices adulterants	Frequency	Percent
Ground black pepper	48	19.8
Chili powder	43	17.5
Turmeric	26	10.5
Paprika	21	8.4

Sawdust	11	4.7
Have no idea	96	39.1
Total	**245**	**100.0**

Commonest Forms of Fruits Juice Adulterants

With this item, it sought to establish from the respondents the most common adulterants used to adulterate fruit juice products in the various catering facilities. Accordingly, the respondent's responses on the substances mostly used to adulterate fruit juice have been presented in Table 3. Results from Table 3 suggest that most of the respondents thus, 42.9% identified sugar as the substance often used to adulterate fruit juice products to make it sweeter and tastier to the consumer. Again, colour was identified as the second highly used substance to adulterate fruit juice products. Specifically, 29.1% of the respondents identified it as the substance commonly used to adulterate fruit juice. Also, the flavour was identified by 17.5% of the respondents as the commonly used substance to adulterate fruit juice. However, water was identified as the least substance often used to adulterate fruit juice. It was listed by 10.5% of the respondents as the substance commonly used in adulterating fruit juice. Results from the study suggest that sugar became the most used substance to adulterate fruit juice whereas water became the least used substance to contaminate fruit juice products.

Table 3: Commonest Forms of Fruits Juice Adulterants

Fruit juice adulterants	Frequency	Percent
Sugar	105	42.9
Water	26	10.5
Colour	71	29.1
Flavour	43	17.5
Total	**245**	**100.0**

Commonest Forms of Palm Oil Adulterants

Results on the substances often used to adulterate palm oil products within the Ghanaian market have been presented in Table 4. Results from Table 4 show that a little over 60% of the respondents identified colour as the main contaminant often used to adulterate palm oil products in Ghana. Moreover, the textile dye was identified as the second highly used substance often used to adulterate palm oil products in Ghana. It was identified by 30.3% of the respondents as the substance often used by the market women to contaminate palm oil. However, 9.1% of the respondents had no idea as to the kind or types of substances often used to contaminate palm oil products in Ghana. Results from the study suggest that most of the respondents knew about the main adulterants often used by the market women or palm oil sellers when it comes to adulterating palm oil. Hence, colour and textile dye were identified as the main substances often used in Ghana to contaminate palm oil.

Table 4: Commonest Forms of Palm Oil Adulterants

Palm oil adulterants	Frequency	Percent
Colour	148	60.6
Textile dye	74	30.3

Have no idea	23	9.1
Total	**245**	**74.7**

Commonest Forms of Olive Oil Adulterants

Results on the substances often used to adulterate olive oil products in Ghana have been presented in Table 5. Results from Table 5 suggest that nearly half of the respondents that is 47.8% identified lower-cost substitutes, such as olive oil from different origins as the most used material to adulterate olive oil products. Also, 33.8% of the respondents listed soya bean oil as the number one substance often used to adulterate olive oil products. Again, a small section of the respondents that is, 3.3% listed legume oil as the alternative oil that is often used to adulterate olive oil products. More so, it was established that a little over 15% of the respondents had no idea about the substances that are often used to adulterate olive oil products. Their lack of knowledge or awareness about the substances used to adulterate olive oil suggests that they may not be able to identify an adulterated olive oil when they see one in the market. Generally, results from the study suggest that lower-cost substitutes, such as olive oil from a different origin and soya bean oil constituted the main substances that were often used to adulterate olive oil products in Ghana.

Table 5: Commonest Forms of Olive Oil Adulterants

Olive oil adulterants	Frequency	Percent
Lower-cost substitute, such as olive oil from a different origin	117	47.8
Soya bean oil	83	33.8
Legume oil	8	3.3
Have no idea	37	15.1
Total	**245**	**100.0**

Commonest Forms of Ground Coffee Adulterants

Results on the substances commonly used to adulterate ground coffee products in Ghana have been presented in Table 6. Results from Table 6 suggest that majority of the respondents that is, 55.9% had no idea on the kind of substances often used to adulterate ground coffee products in Ghana. However, to 19.8% of the respondents, roasted corn constituted the product often used to adulterate ground coffee products in Ghana. Again, to 14.2% of the respondents, ground roasted barley was usually used to adulterate most ground coffee products. However, 6.1% and 4.0% of the respondents respectively identified sawdust and other plants roots as the substances frequently used to adulterate ground coffee products. Results from the study suggest that even though materials such as roasted corn, ground roasted barley, sawdust, and plants roots were identified by 44.1% of the respondents as the substances often used to adulterate ground coffee products yet a substantial number of the respondents thus, 55.9% could not tell whether these substances formed part of the materials often used to adulterate ground coffee products in Ghana.

Table 6: Commonest Forms of Ground Coffee Adulterants

Ground coffee adulterants	Frequency	Percent
Roasted corn	49	19.8
Sawdust	15	6.1

Ground roasted barley	35	14.2
Other plants	10	4.0
Have no idea	136	55.9
Total	**245**	**100.0**

Consumer Level of Knowledge and Awareness on the Health Effect of Food Adulteration

This objective sought to assess respondents' level of knowledge and awareness on the health consequence associated with food adulteration. Accordingly, the respondents' responses on their level of knowledge and awareness on the health consequence of food adulteration have been presented in Table 7. Results from Table 7 suggest that the item with the highest percentage of correct response is item 8. The correct response to this item is 'True'. 69.4% of the respondents answered this question correctly while 30.6% responded to this question incorrectly. Again, the item with the second-highest percentage of correct response went to item 1. On this question, the correct response is'True. With this item, 67.3% responded correctly by selecting true whereas 32.7% responded incorrectly. The item with the third-highest percentage of correct score went to item 6. On this item, 63.3% answered it correctly by selecting 'True' whereas 36.7% answered it incorrectly by selecting 'False'. Item 12 became the item with the fourth-highest percentage of correct answers. Particularly, on this item, nearly 60% of the respondents were able to respond correctly to this question. In contrast, 42.9% of the respondents could not respond correctly to this question. The correct answer to this question is 'True'.

Moreover, among the 12 items here, it was with item 3 and item 10 where most of the respondents answered these questions incorrectly. Apparently, on item 10, (eating foods that have been adulterated with artificial sweetener could cause the individual nervous system disorder and depression), 93.9% of the consumers answered this question wrongly. Meaning, it was only 6.1% of consumers knew that eating foods that have been adulterated with artificial sweeteners could cause nervous system disorder and depression. Also, with item 3 (eating foods high in excessive additives could cause infertility in women) results from Table 7 suggest that 71.4% of the respondents answered this question incorrectly. Interestingly, it was only 28.6% of the respondents answered this question correctly. This suggests there was a more incorrect answer to this question than correct responses.

Results from the study suggest that the understudied consumers had average knowledge about the health implication of food adulteration. For instance, their knowledge was mostly limited on how food adulteration could trigger recurrent vomiting and nausea and how adulterated food could result in adverse health conditions such as abdominal pain as well as how adulterated food could cause sleeping disorders, and indigestion. However, when it comes to how food adulteration could trigger specific health conditions such as hypotension, cardiac problem, multiple organ failure, nervous system disorder and depression, kidney failure, and infertility in women, it was revealed that only a small section of food providers and consumers knew that continuous consumption of adulterated food could result into these health problems.

Table 7: Level of Knowledge and Awareness on the Health Effect of Food Adulteration

Items	True	False
	Freq (%)	**Freq (%)**

1	Food adulteration could cause the individual eye itching, eyes redness and watering of the nose.	165(67.3)	80(32.7%)
2	Eating foods that have been adulterated with artificial sweetener could cause the individual sleeping disorder, and indigestion.	125(51.0%)	120(48.9%)
3	Eating foods high in excessive additives could cause infertility in women.	70(28.6%)	175(71.4%)
4	Consuming adulterated foods could trigger recurrent vomiting and nausea.	135(55.1%)	110(44.9%)
5	Melamine which is noted for adulterating milk is known to pose a public health threat.	100(40.8%)	145(59.2%)
6	Consuming oil that has been adulterated with nut or legume oils pose a problem for consumers with allergy.	155(63.3%)	90(36.7%)
7	Eating fruits that have been adulterated with ripener could expose someone to liver problems and respiratory difficulty.	100(40.8%)	145(59.2%)
8	Consuming adulterated foods can result in serious consequences, and possibly lead to the person death.	170(69.4%)	75(30.6%)
9	Fish products injected with formalin or dip in water treated with chemicals, such as chlorofluoro carbon and DDT powder can cause kidney failure.	65(26.5%)	180(73.5%)
10	Eating foods that have been adulterated with artificial sweetener could cause the individual nervous system disorder and depression.	15(6.1%)	230(93.9%)
11	Consuming adulterated foods for a prolong time will in the extreme case result in hypotension, cardiac problem and multiple organ failure.	135(55.1%)	110(44.9%)
12	Adulterated foods can result into adverse health condition such as abdominal pain and even in some cases result into breathing difficulty.	140(57.1%)	105(42.9%)

Discussion

Common forms of food adulterations in the Ghanaian market

This objective sought to identify the common forms of food adulterations in the Ghanaian market and the related materials used in adulterating these foods items. On this objective, it was observed that the main substance used to adulterate black pepper was papaya seed. On black pepper, 52.4% identified papaya seed as the ingredients mostly used to adulterate black pepper in most of the Ghanaian markets. Also, to 32.4% of the respondent, chili powder was the most used substance to adulterate black pepper in Ghana. A small section of the respondents that is, 1.4% identified millet as the ingredient often used to adulterate black pepper. Additionally, when it came to adulterants often used to adulterate culinary spices, 39.1% of the respondent could not identify the kinds of items used to adulterate culinary spices. However, 19.8% of the respondents listed ground black pepper as the item often used to adulterate culinary spices. Also, 17.5% of the respondent's chili powder constituted the common ingredient often used to adulterate culinary spices in most Ghanaian markets. Again, 10.5% of the respondents identified Turmeric as the common source of additive used to adulterate culinary spices. Again, when came to the kind of items used to adulterate fruit, it was established that 65.0% of the respondents identified calcium carbide as the item used to increase the ripening rate of fruits especially when it comes to fruits like mango, banana, pear, and pineapple. Again, it was revealed that 17.5% of the respondents said most of the fruit sellers used sand that is, buried the fruits in the sand to increase their ripening rate. Also, 11.7% of the respondents identified DDT as the contaminant often used in the Ghanaian market to increase fruit ripening.

Also, when it comes to the substances used to preserve fish and other meat products from rotten, 62.9% of the respondents identified formalin as the product often used to prolong the life span of fresh fish. This revelation is quite horrifying since this chemical is mostly used to disinfect dead bodies and other biological specimens from decaying. Again, 18.9% of the respondents identified DDT as the other chemical substances used by most meat sellers to preserve their meat and fish products for decaying.

When it came to fruit juice adulterants, 42.9% of the respondents identified sugar whereas 17.5% identified flavour as the substances often used to adulterate fruit juice products. Again, colour was identified as the second highly used substance to adulterate fruit juice products. More so, on the substances used to adulterate palm oil, a little over 60% of the respondents identified colour as the main contaminant often used to adulterate palm oil products in Ghana. On the other hand, 30.3% of the respondents identified textile dye as the second highly used substance to adulterate palm oil products in Ghana.

The adulterants established to use in the Ghanaian market by the market women happens not to be very different from the one listed in the study of [22] and [23] as items such as sugar and natural sweeteners were found to be often added to honey to increase its volume. Even though, results from the study affirm the work of [24] as their results identified papaya seeds to be the most used item to adulterate black pepper it has to be added that other new items such as chili powder and ground millet were also identified in this study as part of the items used to adulterate black pepper. Moreover, as established in the study of [25] using papaya seeds to adulterate black pepper can become very deadly to the human body as it can cause consumers liver and stomach problems, and can become a major source of health risk to consumers hence, having most of the respondents having full knowledge on this adulterant is a great sign of relieve as their high level of awareness about this practice could enable them to notice it when they see it in their food. Likewise, results from this study corroborate that of [27] as their work found a lower-cost substitute, such as olive oil from a different origin or any other type

of oil as the food products often used to adulterate olive oil. Specifically, in this study lower-cost substitutes, such as olive oil from a different origin and soya bean oil were found to as the most used items to adulterate olive oil in Ghana. Again, the result from this study is consistent with the work of [39] as items such as sugar, sweetener, and flavours were identified as the adulterants mostly used to adulterate fruit juice products.

Consumer Level of Knowledge and Awareness on the Health Effect of Food Adulteration

On this objective, it sought to assess respondents' level of knowledge and awareness on the health consequence associated with food adulteration. Results from the study suggest that the understudied consumers had fair knowledge about the health implication of food adulteration. For instance, the respondents knew that consuming adulterated food could trigger recurrent vomiting and nausea. Again, it was observed that most of the respondents were aware that consuming adulterated food could result in adverse health conditions such as abdominal pain, breathing difficulty, sleeping disorder, and indigestion. For instance, 55.1% of the respondents knew that consuming adulterated foods continuously could result in health conditions such as hypotension, cardiac problem, and multiple organ failure. As indicated earlier, it was not in cases that the respondents knew about all the health consequences associated with the consumption of adulterated foods. For instance, results from the study show that only 6.1% of the respondents knew that eating foods that have been adulterated with artificial sweeteners could cause nervous system disorder and depression. The study shows that about 26.5% of the respondents knew that fish products injected with formalin or dip in water treated with chemicals, such as chlorofluorocarbon and DDT powder can cause kidney failure.

The study respondents' level of knowledge on the health consequence associated with the consumption of adulterated food tends not to be very different from the results found in the study of [12]. For instance, in the case of [12], close to half of the respondents knew that consuming adulterated foods could adversely affect a person's health, especially for consumers with allergic disorders. Similarly, in this study context, it was observed that a little over half of the respondents knew that consuming oil that has been adulterated with nut or legume oils could pose a health problem to the consumer especially those with allergic reactions. Also, results in this study align with the findings of [14], as in their study it was observed that almost half of the consumers were very much aware that the various chemicals and colors used to speed up fruit ripening and preserve vegetables could pose dangerous harm to the consumer. In this study, it was observed that 40.8% of the consumers knew that eating fruits that have been adulterated with ripener could expose them to liver conditions problems and respiratory difficulty. Similarly, results from this study affirm the earlier work of [13] and that of [25] as in their respective studies, it was observed that most consumers had a strong perception that consuming foods that have been contaminated chemically or naturally can result in health implications such as diarrhea, abdominal pain, nausea, vomiting, eyesight problem, headache, cancer, kidney failure, digestive system disorders, etc. Likewise result from the study is in line with the work of [16] as their results identified that a little over 50% of their respondents were aware of food adulteration and its associated effect on consumer health. Conversely, findings from this study are inconsistent with the work of [18] and that of [17] as their work observed that most of the consumers in their study had lower awareness about adulteration as well as its damaging effect it tends to have on a person health.

Conclusion

Many studies have found that there is a lot of adulteration in various food products, and that when these food products are consumed; they cause a host of health issues for consumers. However, it is unknown how much of

the general population is aware of the adulteration and its health implications. According to the bulk of the studies reviewed, consumers were moderately aware of adulteration but unable to detect it at home. They were also unaware of the dangers of consuming tainted foods. Results from the study suggest that consumers had fair knowledge about the health implication of food adulteration. For instance, the respondents knew that consuming adulterated food could trigger recurrent vomiting and nausea. The majority of the respondents knew about most of the substances often used on the Ghanaian market to adulterate food, whereas few respondents could not identify the substances used in adulterating food.

Recommendations

It is recommended to the Public Health Directorate of the Ghana Health Service to have a policy those resource health facilities across the country with a relevant document on food adulteration that can be freely given to the local people. Also, the Ministry of Health to do intensive public training, particularly concerning the health consequences associated with the consumption of adulterated foods. Also, the Ministry of Health should have a policy document that directs public hospitals within the country to help food and nutrition unit to regularly educates patients that come to the hospitals on the health consequences of food adulteration

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