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Research Article

Consumers' Knowledge of Food Adulteration and Commonly Used Methods of Detection

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Food adulteration has become a threat to many countries as most individuals have consumed food items without knowing that it has been adulterated, leaving the consumer with various ailments. This study identifies the degree of adulteration in some commonly used food items bought by consumers and the means of detection. The study comprised 384 women who patronized various food items for food preparation. They were asked if they have come into contact with adulterated food products before and to illustrate how they detect if a food item is adulterated. From the findings of this study, the respondents indicated that they will not consume a food item if they get to know that it has been adulterated, and 50.5% indicated that they have come into contact with adulterated food during preparing food. Various reasons were given by the respondents why they will not consume adulterated food, and the reasons included the following: the food may be dangerous to consume and not healthy for consumption and can cause stomach disorders. Few numbers (11 out of 384) of the respondents also indicated that they will still go ahead and consume adulterated food items since not all adulterants are toxic. Food items that are prone to adulteration as mentioned by the respondent included groundnut paste, chilli pepper, tomato powder, and honey with their adulterants ranging from flour, colour, Sudan IV dye, chalk powder, foam, cola nut powder, avocado pear seed powder, and many more. Means of detecting the presence of adulterants as indicated by the respondent were sensory and textural characteristics due to the cost involved in the use of other advanced techniques.

1. Introduction

Gone were the days when there was little or no incidence of food fraud when people used to live in small groups and practised subsistence farming just to feed themselves. Nevertheless, with the increase in population, urbanization, and demand for more convenient, available, and ready-to-serve food products, the temptation of adulteration mostly during the scarcity of food and the possibility of economically motivated profit has increased. The final target of such misconduct is mostly the consumer who unknowingly buys and consumes these foods and may suffer from health-related issues. According to Giannakas [1] and UK National Food Crime Unit [2], widespread issues of food adulteration may decrease consumers' confidence in food labelling policy, and this will in turn build financial and reputational damage to firms and the food industry.

Despite the increasing awareness of the need to know and combat food deceit, little has been done to know consumers' knowledge and perceptions of food adulteration. While most research studies focus on food hygiene, there is a lack of information about consumers' knowledge regarding food adulteration. There is a significant gap in the empirical evidence to know consumers' knowledge of food adulteration and how this knowledge has influenced their food choice. The awareness of consumers will play an important

role in preventing food adulteration [3] since nowadays the practice of food adulteration is common in our food chain.

The substances, usually termed adulterants, could be chemicals or any material of inferior quality or being useless which are not to be present in the food and may be intentionally added to reduce manufacturing costs or for a cruel purpose [4]. Some of the common substances or adulterants used may include wood saving, other plants, seeds of similar colour in powdery form, sand, marbles, food colour, and filth that have been found in the herbs and spices category of food products. Low-priced edible and nonedible oils are generally used for adulterating high-grade oil such as extra virgin olive oil.

Adulteration of food is usually done through mixing, substituting, abstracting, and concealing the quality of the food product. This activity reduces the quality of the food substance, and its consumption may be fatal to the health of the consumer [5–7]. In other instances, a nonfood substance is intentionally added to a food product to improve the appearance or the outcome of the product. An example is the addition of Sudan IV dye to palm oil to bring out the red colour even though the use of Sudan IV dye as a food additive has been banned. Other food items and their common adulterants have also been reported, including the adulteration of red wine with the juice of bilberries, sugar with chalk powder, honey with cane sugar, chilli powder with brick powder, and black pepper with papaya seed [3]. The brain behind these malpractices is mainly for economic gain and not necessarily to improve the nutritive quality of the food product. The health of the consumer who is innocent about the content of the food to be consumed is therefore at stake. However, not all adulterants are harmful to human health. An example is the addition of water to cow milk, although this must be made known to the consumer or be written on the label.

At this present time, the traceability of food is restricted to the quality of each processor's documentation. When consumers have doubt or suspected fraud in a particular food product, there is no standardized analysis available to discriminate a good product from an adulterated one. Although there may be basic screening tests for determining adulteration, there is no empirical evidence of this practice. Again, despite the advancement in technology in the developed world, there is little or lack of technology in the developing countries to detect fake and adulterated food products. Nevertheless, detection of adulterants in food items is necessary to assess the authenticity and to protect consumers against fraudulent activities. The present study aims to evaluate consumers' knowledge and determine the degree of contamination in some commonly used food items bought by consumers and the means of detection of the adulterant.

2. Materials and Methods

2.1. Selection of Respondents and Sample Size Determination. The study was conducted in Ho of the Volta Region of Ghana. The target populations were women above the age of 18 years. The respondents were either housewives or working. In this study, a sample size of 384 was estimated using the RAOSOFT sample size calculator [8]. The sample size was calculated assuming a confidence level of 95%, a 5% margin of error, and a response distribution of 50%. The sample size n and the margin of error E are given by

$$X = Z\left(\frac{c}{100}\right)^2 r(100 - r),$$

$$n = \frac{Nx}{((N-1)E + x)}, \quad (1)$$

$$E = \mathrm{Sqrt}\left[\frac{(N-n)x}{n(N-1)}\right],$$

where N denotes the population size, n denotes the sample size, r denotes the fraction of the response of the interested group, E denotes the margin of error, and Z(c/100) is the critical value for the confidence level, c.

Probability sampling was used in this study to ensure a good representation of the population. A simple random sample of clusters was employed in selecting participants from the population.

2.2. Data Collection Tools and Procedures. A pretested questionnaire was designed for data collection regarding respondents' knowledge of food adulteration, adulterants normally used to adulterate food items, and the means of detection at the household level. Participants were provided with all necessary consent forms to read and fill upon agreement to participate in the study. The questionnaires were effectively administered and collected, as the researchers personally took them to the participants and administered them one-on-one, translating the content of the questions to people who could not read or understand them.

2.3. Data Analysis. The data obtained from the study were analysed using Statistical Package for Social Sciences software (SPSS) version 22.0 [9]. Descriptive statistics were used to summarize the processed data into frequencies and percentages using tables.

3. Results

3.1. Respondents' Sociodemographic Characteristics and Knowledge of Food Adulteration. The study was sorted to determine respondents' knowledge about food adulteration and their contact with an adulterated food product. The results of the study show that the majority (41.1%) of the respondents were between the ages of 18 and 35 as shown in Table 1. Very few of the participants were above the age of 55 years. Those who were single formed the majority (51.6%), and 3.1% were cohabiting. In terms of the educational background of the respondents, 15.9% had completed middle school with 15.6% having no formal education. Most of the respondents, 37.8%, were in tertiary education or had completed. A greater part of the respondents were Christians (88.8%), and 1.3% belonged to other forms of religion. The

Table 1: Sociodemographic characteristics of respondents.

Characteristics	Parameters	Frequency	%
Age (years)	18–25	158	41.1
	26–35	114	29.7
	36–45	72	18.8
	45–55	30	7.8
	>55	10	2.6
Ethnicity	Ewe	217	56.5
	Akan	83	21.6
	Ga-Adangbe	44	11.5
	Northerner	29	7.6
	Others	11	2.9
Religion	Christianity	341	88.8
	Islam	31	8.1
	Traditional	7	1.8
	Others	5	1.3
Marital status	Single	198	51.6
	Married	134	34.9
	Divorced	23	6.0
	Widowed	17	4.4
	Cohabit	12	3.1
Educational background	Nonformal	60	15.6
	Primary	23	6.0
	Middle school/JHS	61	15.9
	SHS/vocational	59	15.4
	Diploma	36	9.4
	Tertiary	145	37.8

bulk of the respondents were Ewes (56.5%) due to the chosen study area.

Knowledge about food adulteration was high (274, 71.4%), and a greater part of the respondents had known about food adulteration for more than one year (Table 2). More than half of the respondents (66.1%) thought that if the price of a food product is lower than expected or too good to be true or the quantity is more than expected, the food product might have been adulterated.

A little over 50% of the respondents said they have bought food products and have suspected adulteration as shown in Table 3. Besides having physical contact with an adulterated food product, 47.4% have heard about other substances that are being used to adulterate food. A majority of the respondents (92.2%) interviewed said they are not willing to purchase a food product if they know it is adulterated in any form. Surprisingly, 7.8% of the respondents said they will go ahead and buy the adulterated food product. Out of the 384 respondents, 199 gave reasons for their choice of answers when interviewed (Table 4).

Thirty (30) of the respondents claimed that they will buy an adulterated food product even if they are certain it is adulterated, while 347 said they will not buy. Table 4 represents the reasons behind the decision made by the respondents. Out of the 30 respondents who said they will buy an adulterated food product, 11 gave out the following reasons: not all adulterated food is harmful, the food product is still needed in the diet, and it might serve as a preservative and lastly as evidence of food adulteration. Additionally, out of the 354 respondents who said they will not buy adulterated food, 188 of them gave reasons for their decision as shown in Table 4. A majority of the respondents (96) claimed that it is very dangerous to consume an adulterated food product.

3.2. Common Adulterated Food Items. The respondents were asked to name any food product they have bought and realized it was or had been adulterated. The 194 (50.5%) respondents as shown in Table 3 who attested to the fact that they have purchased food products and realized it was or had been adulterated mentioned groundnut paste, powdered chilli pepper, tomato paste, tomato powder, honey, palm oil, sugar, and beef as some of the food products prone to adulteration (Table 5). According to the respondents interviewed, the food products that are most prone to adulteration are powdered chilli pepper followed by groundnut paste, honey, and palm oil. The adulterants mostly used to adulterate powdered chilli pepper, groundnut paste, honey, and palm oil are food colour, kokonte flour (dried milled cassava), burnt sugar, and Sudan dye, respectively. Other adulterants such as saltpetre, salt, sawdust, guava seeds, papaya seeds, the bark of the cassia plant, and chalk were reported by the respondents as some of the substances they saw in the food products they usually buy at the market (Table 5).

3.3. Detection of Food Adulteration by Respondents. Various traditional means of detecting food adulteration were made known by the respondents as shown in Table 6. The respondents indicated the use of cassava flour or spoiled wheat flour as adulterants for groundnut paste. To detect the presence of flour in groundnut paste, the majority (9) of the respondents indicated that when the groundnut paste is used to prepare soup, the soup becomes thick. The presence of flour in the groundnut paste also shows the presence of white crystals. Lighter groundnut paste was an indication of the addition of oil.

Regarding the detection of adulterated pepper, the majority (7) of the respondents indicated that the addition of other substances to increase the bulkiness of the pepper reduces the hotness of the pepper. This informs the consumer that the pepper has been adulterated. Again, the addition of other substances to the pepper also reduced the usual strong and sharp scent of the pepper. According to some of the respondents, the intense red colour of pepper indicates the addition of colour.

Again, the responses showed that the presence of adulterants in tomato powder can be notified after it has been mixed with water in a container. Other particles or substances usually settle at the bottom of the container. Tomato powder is usually not very red; hence, any unusual red colour is a result of colour addition. Furthermore, tomato in the form of paste is perceived to be adulterated with flour if there are signs of thickness.

Respondents mentioned various means of detecting the presence of adulterants in honey as shown in Table 6. Most of the respondents (9) indicated that honey is usually thick; hence, any form of adulteration with water will cause it to be

Table 2: Respondents' knowledge about food adulteration or authenticity.

		Frequency	%
Do you know anything about food adulteration?	Yes	274	71.4
	No	110	28.6
For how long have you known of food adulteration (years)?	<1	62	22.6
	1–5	117	42.7
	6–10	54	19.7
	>11	41	15.0
If the price of a food item is lower than expected or too good to be true, or the quantity is more than expected, would you expect food adulteration?	Yes	181	66.1
	No	93	33.9
Have you heard of any issues about food fraud or adulteration in Ghana on television or media?	Yes	87	22.7
	No	297	77.3
Did you hear of the recent recall of a certain canned tomato paste from the Ghanaian market?	Yes	178	46.4
	No	206	53.6
Do you consider the place of purchase as important in determining the authenticity or genuineness of a food product?	Yes	263	68.5
	No	121	31.5

Table 3: Knowledge of respondents regarding food authenticity.

Question	Response	Frequency	%
A. Have you ever bought food/food products and realized it has been adulterated or you have been deceived or fraud?	Yes	194	50.5
	No	190	49.5
B. Do you know or have you heard of any other Ghanaian foods or food products that are being adulterated?	Yes	182	47.4
	No	202	52.6
C. Will you buy a food product when you know it is adulterated?	Yes	30	7.8
	No	354	92.2
D. Any reason for your chosen option in (c)	Yes	199	51.8
	No	185	48.2
E. Do you know of any means of determining whether a particular food product has been adulterated?	Yes	95	24.7
	No	289	75.3

Table 4: Respondents' reasons for buying or not buying an adulterated food product.

Yes, specify	Will you buy a food product when you know it is adulterated		Total
	Yes	No	
	19	166	185
Sickness	0	11	11
Food contamination	0	2	2
Not original	0	8	8
Not all adulterated food is harmful	6	0	6
Still need it to prepare food	2	0	2
Reduce quality (nutrients)	0	8	8
If it is there to serve as a preservative	1	0	1
Waste of money	0	2	2
As a piece of evidence that food adulteration is common	2	0	2
Change in taste	0	1	1
It is not good	0	2	2
Dangerous	0	96	96
Stomach upset	0	7	7
Food poisoning	0	8	8
Unhealthy to eat	0	24	24
It will not taste good	0	4	4
Can cause death	0	6	6
Can cause deadly disease	0	7	7
Makes food bulk (plenty)	0	2	2
Total	30	354	384

Table 5: Common adulterants in food items reported by the respondents.

Food items	Adulterants	Frequency	%
Groundnut paste	Kontonte flour	55	70.5
	Corn flour	12	15.4
	Do not know	5	6.4
	Water	1	1.3
	Vegetable oil	2	2.6
	Colour	2	2.6
	Flour and oil	1	1.3
Powdered pepper	Food colour	30	34.1
	Pear seed flour	12	13.6
	Spices	1	1.1
	Flour and colour	9	10.2
	Do not know	10	11.4
	Sawdust	1	1.1
	Cola nut	22	25.0
	Prekese	1	1.1
	Maggi	1	1.1
	Flour	1	1.1
Tomato paste	Starch	4	28.6
	Colour	8	57.1
	Bissap leaves	1	7.1
	Do not know	1	7.1
Honey	Burnt sugar	37	69.8
	Do not know	3	5.7
	Water	8	15.1
	Burnt foam	3	5.7
	Starch	2	3.8
Tomato powder	Food colour	6	60.0
	Wheat flour	1	10.0
	Do not know	2	20.0
	Colour plus unknown substance	1	10.0
Dzowoe	Corn flour	1	100.0
Light soup	Yam or cassava stock	6	85.7
	Corn flour	1	14.3
Foreign rice	Local rice	5	80.0
	Rubber rice	1	20.0
Roselle juice (sobolo)	Food colour	3	100.0
Fufu	Palm oil	4	80.0
	Guava leaves	1	20.0
Banku	Gari as cassava dough	2	100.0
Kokonte flour	Corn flour	3	100.0
Wheat flour	Corn flour	2	50.0
	Poultry feed	2	50.0
Fried yam	Colour	2	66.7
	Sugar	1	33.3
Bread	Citrine	2	100.0
Powdered spices	Sawdust	1	25.0
	Spoiled spices	1	25.0
	Industrial chemicals	2	50.0
Kenkey	Cassava dough	8	100.0
Palm oil	Sudan dye	40	97.6
	Starch	1	2.4
Coconut oil	Shea butter (melted)	1	100.0
Milk powder	Bread flour	1	33.3
	Nondairy creamer	2	66.7
Ginger powder	Do not know	2	100.0

Table 5: Continued.

Food items	Adulterants	Frequency	%
Ice cream	Colour	2	66.7
	Flour	1	33.3
Cooked beans	Saltpetre	2	100.0
Beef	Colour	15	100.0
Turmeric	Colour	2	50.0
	Sawdust	1	25.0
	Yellow dye	1	25.0
Shrimp powder	Fish head (dried)	1	100.0
Agushi powder	Flour	1	100.0
Cassava dough	Salt	1	100.0
Milk	Water	7	63.6
	Flour	2	18.2
	Starch powder	1	9.1
	Chalk powder	1	9.1
Olive oil	Tea tree oil	1	100.0
Sugar	Chalk powder	12	85.7
	Flour	1	7.1
	Washing powder	1	7.1
Black pepper	Papaya seed	5	100.0
Coffee seed powder	Tamarind seed powder	2	100.0
Kebab powder	Pear seed powder	1	100.0
Tea leave	Coloured leaves	1	100.0
Common salt	Kadamire brick powder	1	14.3
	Flour	6	85.7
Fish	Oil	3	100.0
Cinnamon sticks	Bark cassia plant	1	100.0
Cummins seeds	Sawdust	1	100.0
Pulses	Dyes	1	100.0
Tea	Artificial colouring agents	2	100.0
Jollof	Colour	3	100.0
Fruits and vegetables	Cobalt	1	100.0

light and spread easily. Again, 6 of the respondents indicated that when the cotton wick is dipped in honey, pure honey will burn, but adulterated honey with water will give a cracking sound. While other respondents said they could detect whether honey is pure by freezing it, some also said when it is very sugary is an indication that it was adulterated with sugar.

To detect the presence of colour in palm oil, the respondents mentioned that if the oil stains your tongue after eating it, then there is a suspicion of adulteration. Some also indicated that adding drops of iodine to the red palm oil will change the colour to blue-black indicating the presence of starch.

4. Discussion

Food adulteration has been a menace for the past decade. Adulteration of food reduces the nutritional quality and may also pose some adverse health effects to the end consumer. This study showed that the higher number of respondents knowing food adulteration could mean that consumers with prior knowledge of adulterated food items should be able to choose food items carefully. Studies by Meerza and Gustafson [10] reported that consumers' knowledge of food adulteration made them decrease their willingness to pay for extra virgin olive oil by $4.53 when they received information about extra virgin olive oil adulteration or fraud from other countries. They argue that consumers with no prior knowledge of food fraud will react more when they receive information about food fraud. The negative spillover effect of food fraud of a particular food product can decrease consumers' willingness to pay for the same product from other countries. This means that the deceitful behaviour of one country can roll over to other countries. Consumers who have prior knowledge of food adulteration incidents, therefore, tend to be more conscious when they receive information about food adulteration.

Most people adulterate food to increase its bulkiness, thereby increasing the quantity of the food product on sale. This means that the behaviour of eating any food product can be determined by consumer level of education and other sociodemographic factors. Issues about food adulteration known by the respondents were low as shown in Table 2, and this can be seen in the responses given when asked about the recent recall of tomato paste on the Ghanaian market due to suspected tomato paste fraud and adulteration. Only 46.4% indicated hearing of the incidence, meaning that the campaign and broadcasting of adulteration of food are very low as shown in this study.

Table 6: Traditional means of detecting food adulteration by the respondents.

Food products	Means of detection by respondents	Frequency	%
Groundnut paste	Not smooth or presence of particle	3	16.7
	Thickening soup	9	50.0
	Looks whitish	4	22.2
	Appears lighter with oil	1	5.6
	Soup looks gelly	1	5.6
Powdered pepper	Looks very red	3	11.5
	Pepper is not hot as usual	17	65.4
	Different odour other than that of pepper	3	11.5
	Taste sweet	1	3.8
	Smells differently	1	3.8
	Mostly moist because of the adulterants	1	3.8
Tomato powder	Unknown particles settle when mixing with water in a container	5	83.3
	Looks very red	1	16.7
Bread	The addition of citrine makes the bread very sweet	2	100.0
Tomato paste	Flour addition makes it very thick	2	33.3
	Looks pale than the usual red colour	4	66.7
Honey	The presence of sugar attracts ants	3	8.6
	Watery when diluted with water and spread easily	9	25.7
	Flammable when pure	2	5.7
	When you get stomach upset after taking it	1	2.9
	Rub in the palm for the presence of particles	1	2.9
	Put a spoon of honey in a cup of water; pure honey will settle at the bottom	1	2.9
	Cotton wick dip in pure honey will burn, but a cracking sound will be heard if there is water in the honey	6	17.1
	Pure honey will not freeze in a freezer	3	8.6
	Change in original taste and thickness	1	2.9
	Adulterated honey will break at intervals when pouring it out from a spoon or container	1	2.9
	Pure honey will settle when mixed with water, but adulterated one will mix quickly with water	2	5.7
	Pure honey leaves traces on a smooth surface	3	8.6
	Taste very sugary	2	5.7
Spices	Mix with water and allow to settle. Adulterants will suspend	1	100.0
Ice cream	Looks like porridge when flour is added	1	100.0
Fried yam	Looks very yellow	3	75.0
	Taste sweet indicating the addition of sugar	1	25.0
Kenkey	Malleable	1	20.0
	Gummy	3	60.0
	Taste like banku	1	20.0
Palm oil	Taste different	4	44.4
	Stain your tongue after eating	1	11.1
	Colour changes to dark red upon heating indicating adulteration	3	33.3
	Add drops of iodine to red oil; if the colour changes to blue-black, this indicates adulteration with starch	1	11.1
Ginger powder	It will not smell and taste like the original ginger	2	100.0
Meat (beef)	Soaking in water will get rid of the adulterants (colour)	3	100.0
Milk powder	Mix with water, and adulterants will suspend	1	100.0
Plastic rice	Burning the rice will cause it to melt	2	100.0
Milk	Put a drop of milk on a vertical surface; if it flows slowly, then it is not adulterated	4	66.7
	Pure milk will leave traces when allowed to flow on a smooth surface	1	16.7
	Taste different	1	16.7
Sugar	Dissolve sugar in water; the presence of white precipitate indicates adulteration with chalk	8	100.0
Black pepper seed	Black pepper seed will sink in alcohol while papaya seed will float	1	100.0
Mustard seed	The presence of argemone seed will feel rough when rubbing between palm	1	100.0
Coffee	Add coffee powder to water; if the powder settles, it is adulterated	2	100.0

According to Bansal et al. [11], adulteration of food can pose a danger to the consumer. They argued that adulterated food may be toxic and deprived of essential nutrients needed for proper health and can cause intoxication to the individual. Some of the respondents claimed they will consume adulterated food even if they know it has been adulterated. Not all adulterants are harmful to human health, although they are not to be present in the food product.

Food items that are prone to adulteration range from herbs, spices, oil, flour, and pastes with varied associated adulterants. Substances mostly used to adulterate food are cheap and do not add any essential value to the food besides increasing the bulkiness of the food product for economic gain. Market women or vendors usually use dried milled cassava (kokonte flour) to adulterate groundnut paste mainly because it is a cheap product. Substances used to adulterate chilli pepper powder are mostly not as red as the pepper itself. Hence, vendors use colour to mask this colour change to get the red colour back.

Paracetamol and red oil were reported by the respondents as adulterants used in fufu preparation, a favourite dish in most sub-Saharan African countries. Fufu is prepared by pounding cooked cassava and plantain together. In the absence of plantain (when not in season or expensive), food joints use palm oil in place of plantain to obtain the characteristic colour of fufu. Saltpetre and salt were mentioned by the respondents as an adulterant for cooked beans and cassava dough, respectively.

To cover up the sensory defects of the adulterated products, some vendors use chemicals and dyes [12]. While some food items may contain some natural toxins, which may lead to serious adverse health effects when consumed in excess, the deliberate addition of unpermitted colourants or chemical substances such as Sudan dye could be very dangerous to the individual even when present in the smallest quantity. The use of dyes and colours, for example, to spike beef and yam as reported by respondents in this study, is to make them attractive for consumers to buy. In the process, one may be eating metanil yellow, a dye that is not permissible in food. A consumer will therefore be inviting disease instead of eating for good health.

Colourants were also reported as adulterants for beef. Nitrates and nitrites, among other substances, have been reported to be used as a colourant and curing agent in the meat industry to improve the quality characteristics as well as preserve the red colour of the meat. According to a report by Govari and Pexara [13], nitrates are quite nonlethal compared to nitrites, and this has raised some potential health effects in their usage. This activity makes the beef appealing to the buyers. Nevertheless, one does not know the quantity of these substances being used for this purpose and whether it is food grade or not.

Although yellow dye and sawdust were reported by the respondents to have been found in turmeric powder, studies by Kumar [14] and Beniwal and Khetarpaul [15] mentioned chalk powder as adulterants used to adulterate turmeric powder but did not detect the presence of coloured sawdust in any of the turmeric samples. They also found that red chilli pepper powder is mostly adulterated with artificial colour, but respondents in this study mentioned sawdust, pear seed powder, cola nut, maggi, flour, and prekese as some of the common adulterants they have seen in powdered pepper.

Water has also become a common adulterant for most food items that are mostly in liquid form. Several researchers have reported on milk and milk products adulteration, which is a problem in the developing world, where milk marketing is mostly informal, and there is little or no monitoring of the handling practices of market agents [16]. They reported that adulteration of milk implies the addition of any of its components, water or sugar. This was supported by Beniwal and Khetarpaul [15], who found that milk is adulterated with water. This could be attributed to the amount of milk supply which depends on the season. They argue that the source of this water may be from ponds, wells, and rivers, which are likely to be contaminated with bacteria. Kumar [14] also reported adulteration of milk with water to the tune of 70%. The use of synthetic chemicals and detergents such as washing powder as reported in this study (Table 5) for adulterating food items was also reported by Choudhary et al. [3]. This usually causes irreversible damage to the consumer.

The issue of selling fake food products is now common on the market as the perpetrator of these acts plays with consumers' health. A report by Food and Drug Authority (FDA, Ghana) stated that what is being sold on the Ghanaian market as tomato powder is not tomato powder but is annatto seed powder. Food vendors sometimes add colour to the flour like cassava flour or expired wheat flour and portray it as tomato powder. There is currently no tomato powder on the Ghanaian market.

Honey is also another food item that has been susceptible to adulteration with synthetic materials. The two main indicators for the qualitative analysis of honey are fructose and glucose [17]. Adulteration of honey with any substance other than the actual bee honey makes it very dangerous for consumption. The most common adulterants for honey are inverted syrups and other high fructose syrups that are obtained from C3 plants, including cassava and rice [17,18]. In this study, respondents indicated that substances such as foam, sugar, and others are burnt to dark colour and added to the honey to increase its bulkiness for their profit margin. The health implication of these practices is even more serious now that honey and honey product consumption has grown considerably over the last decades [3].

Other substances are also added to food in their preparation to achieve a certain purpose, not necessarily for economic gain. Some of these substances are considered herbs, preservatives, or catalytic agents, and not controlling their usage as food additives can result in a health hazard. In this study, saltpetre, formalin, and salt were reported to have been detected in food items by the respondents. Saltpetre or potassium nitrate (KNO_3) is added to the boiled beans to reduce the cooking time and make them soft or tender. A study by Tugli et al. [19] reported that an overdose of saltpetre can lead to stomach upset and should therefore be used sparingly. Formalin or formaldehyde, on the other hand, is used in laboratories for the preservation of animal specimens. Others also used it in making building materials and pressed wood products such as plywood and glues. Formalin in this current study was used to preserve fish, while others used it to prevent houseflies from settling on them. This agrees with the report by Bansal et al. [11] who stated that meat, fish, and fruits are adulterated with formalin, and consumption of such food items can cause cancer. Salt also is generally used as a preservative or to enhance the taste of the food.

Respondents also mentioned that they have heard that metanil yellow is used to adulterate turmeric powder. Metanil yellow is an artificial colour and a nonpermitted dye in foods. The presence of chalk powder in sugar as reported by the respondents has also been found by other respondents in a study conducted by Beniwal and Khetarpaul [15].

There are various ways of detecting adulterants in food items. Detection of partial substitution of food items has been reported to be difficult, especially before an investigation of the adulterant. Authentication and detection of adulterants in food items could be based on the morphological or organoleptic nature of the food material (colour, texture, and odour) or chemical nature [20]. Detection of adulterants in food items can be demonstrated by the presence of foreign materials, deviation of a component from its normal state, or profiling. The most common among these is the detection of the presence of foreign materials [11]. This can be done through physical methods such as macroscopic and microscopic visual structural analysis, texture, bulk density, solubility, and bleaching of food items. Most of the methods of detection indicated by the respondents were solubility, visual, textural properties, aroma, taste, and rheology of the food item.

Food items adulterated with flour are mostly detected by the thickness and the precipitate it leaves behind when used to prepare food. Flour is mostly used as a thickener in most sauce preparations; hence, its addition to groundnut paste will exhibit that property due to its adsorption capacity. Although groundnut paste contains oil, some sellers of groundnut paste add previously used oil to adulterate the groundnut paste, and this makes the paste lighter and affects the rheological properties of the food item.

Pepper is usually very hot; hence, the addition of other substances to it to increase its bulkiness makes it less hot. In this regard, consumers must add more than necessary to their food to taste or sense the flavour of pepper. From Table 5, most of the adulterants indicated for adulterating pepper are usually not red; hence, the addition of red colour masks the presence of the adulterants. These colours could be food colours or Sudan dye.

Tomato powder is usually scarce compared to chilli pepper powder. When tomato is processed into powder, it is usually not very red. A report by the Ghana Food and Drug Authority in 2016 stated that tomato powder in the Ghanaian market is not necessarily tomato powder [21]. It is an annatto seed that has been ground or milled into powder and is being sold on the market as tomato powder. Hence, such products do not have the flavour of tomato.

Honey is typically thick, and any form of adulteration with water makes it light. The use of burnt sugar and other substances like foam makes the honey look very dark. Other adulterants such as stones, marbles, pebbles, and other foreign materials found in food items are discarded by sieving.

In the absence of advanced technologies such as high-performance liquid chromatography and near-infrared spectroscopy, the local populace can rely on the physical means of fraud detection, which are less costly and require no technical analytical skills [22].

5. Conclusion

The use of useless or other extraneous materials in adulterating food items by fraudsters is mainly to make a profit at the expense of the consumer. Most of the adulteration is deliberate, and the lack of knowledge on the part of the consumers makes it difficult to detect at first sight. Major food items such as groundnut paste, chilli pepper powder, honey, tomato, and palm oil were reported by the respondents as those that are prone to adulteration. Almost all means of adulteration detection reported in this study were by sensory or textural tests, which is a quick screening test that can be performed at the household level and may not have any scientific validity but can give the consumer a broad picture of the nature of adulteration in the food in case of doubt. To avoid consuming adulterated foods, consumers must cultivate the habit of possibly processing their food items, especially the common ones that are prone to adulteration. It is recommended that they buy food from an authentic source and inspect food items critically for any obvious signs of adulteration.

Data Availability

All data are included in the paper.

Conflicts of Interest

The authors declare no conflicts of interest.

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