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Mycoflora, mycotoxin, proximate and mineral composition of selected sachet tomato paste

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ABSTRACT: Tomato (*Solanum lycopersicum*) is highly popular fruit crop grown and consumed by people across the globe. The worldwide production of tomato is very high. Tomato is a wonder fruit fortified with health promoting phyto-chemicals that are beneficial in preventing important chronic degeneration disorder. Tomato are good source of vitamins and minerals also. Tomato can make people healthier and decrease the risk of condition such as cancer osteoporosis and cardiovascular diseases. Unfortunately, these important staple vegetables (tomato) are highly perishable and deteriorate few days after harvest, losing almost all their required qualities and in some cases, resulting into total wastage of the harvest tomatoes. Hence the need to preserve it in forms of concenterates such as tomato paste. This work therefore aims at assessing the probable mycoflora, mycotoxin, proximate and mineral composition of sachet tomato paste. In this study, twenty samples (20) of different brands of sachet tomato paste were purchased within Ibadan. Isolation, identification of fungi, proximate and mineral composition of the paste were done using standard methods while aflatoxin content of the samples was done using enzyme linked immunosorbent assay (ELIZA). The result revealed the occurrence of fungi in the genus *Aspergillus, Fuasrium, Penicillium* and *Neurospora*. The moisture content ranged from 68-755, ash 1.1-3.60, crude fiber 0.47-2.45, crude protein 1.98-4.52, fat 0.04-0.80 and carbohydrate ranged from 16.9-20.87. sodium ranged from 78-107 mg/100, potassium ranged from 123-169, calcium ranged from 35-38 mg/100, magnesium ranged from 0.57-1.21 and iron ranged from 3.88-6.9. Aflatoxin content ranged from 3 -29 ppb. Hence, a strong check and monitoring needs to be put in place by food regulatory agency such as to reduce or totally eliminate the aflatoxins contamination.

Keywords: Aflatoxin, ELIZA, fungi, mineral composition.

INTRODUCTION

Tomato (*Solanum lycopersicum L.*) is a berry annual, short–lived herbaceous plant of the solanaceae family. It is a flag-ship species that belongs to the genus of *lycopersicon* which includes more than 3,000 species with chromosome number of 24; it usually sprawls on the ground, and could reach about 1-5 m height (Wogu and Ofuase, 2014). The fruit is one of the most consumed vegetables in the world, after potatoes and onions, and also the preferred garden crop, ranking 1st in the world for vegetables, with production estimate of approximately 160 million tones, cultivated on 4.8 million hectares in the year 2011 (FAOSTAT, 2011; Ogunbanwo *et al*., 2014).

Nutritionally, the fruit contains calcium, niacin, flavonoids, lycopene, beta-carotene, derivatives of hydroxycinnamic acid, high amount of water and vitamins, specifically A, C, and E which are very vital in metabolic activities of humans (Alsunni and Badar, 2015). The fruit is a versatile health product and due to its equally versatile

preparation option, the fruit is consumed as vegetable, dietary supplement, eaten raw as salad and for cooked food or condiment garnishing, contributing to a healthy well-balanced food.

Tomato has very high moisture content and water activity which makes it susceptible to microbial growth and senescence (Melomey *et al*., 2019). However, tomato fruits can be processed into more convenient and shelf stable food products such as tomato powder, tomato juice, tomato concentrates, tomato paste and tomato purée as a means of preservation and ensuring availability *(*Gupta *et al.,* 2011). Tomato concentrates serve as one of the base ingredients in other food products such as ketchup, soups and sauce (Garcia, 2020). Tomato paste are considerable importance worldwide. In Nigeria, tomato paste is the most important tomato product because of its wide spread use for preparation of various foods/menus. Adequate heat processing is given tomato paste to achieve commercial sterility (Pérez-Tejeda *et al.,* 2016). But subsequent abusive postharvest/handling and storage may lead to undesirable microbiological changes i.e microbial contamination might occur. It is public knowledge that cans of tomato paste often show external evidence of spoilage under tropical retail condition. In addition and interestingly, these defective product are sold (especially to less informed) at the same cost as normal (non-defective) products.

Fungi are major cause of reduction in tomato yields and contaminate food before, during and after (Baiyewu *et al.,* 2007) damage due to mycotoxins – producing fungi (secondary metabolite) goes beyond damage to fruit and may seriously compromise the quality of the tomato paste and also posing risk to the food safely. Tomatoes are highly susceptible to fungi contamination in the field, during processing and storage. *Aspergillus flavus* and *Aspergillus parasiticus* can be found in tomatoes and tomatoes product and both fungi species can produce aflatoxin.

Aflatoxins are a group of toxic, mutagenic, teratogenic and carcinogenic secondary metabolites of fungal origin produced by different *Aspergillus* species such as *Aspergillus flavus* and *Aspergillus parasiticus* (Mazaheri, 2009). Aflatoxin is a common contaminant of agricultural produce resulting from the growth of *Aspergillus* species under conditions of favourable temperature and moisture. This fungal contamination subsequently leads to aflatoxin contamination under favourable environmental conditions (Haruna *et al;* 2019). Furthermore, fungal contamination and subsequent aflatoxin production may occur at various stages, including pre-harvest and post-harvest, post-harvest contamination may lead to changes in the quality and nutritional value of the fruits and vegetables. Aflatoxin are poisonous carcinogen and mutagen that produced by certain molds; which grow in soil, decaying vegetation, hay, and grains, they are regularly found in improperly stored stable commodities such as chilli pepper, tomatoes etc. When contaminated tomato is processed, aflatoxins enter the general processed food (Smith *et al.,* 2008).

In Nigeria vegetables e.g tomatoes are commonly displayed on benches sacks and baskets for prospective buyers, while stored in the open markets, the produce are susceptible to microbial invasion and colonization leading to contamination *(*Muhammad *et al*., 2004). Aflatoxins can gain entrance into tomatoes through plant fertilization with manure, sewage sludge and from irrigated water. Aflatoxin occurs worldwide in a large variety of foods and feeds aside tomatoes, they are thermo stable compound and can cause damages to human and animals *(*Badr *et al.,* 2017). Aflatoxin contamination is the major source of tomato fruits deterioration (Gong *et al*., 2015) and lead to impaired growth in young children when ingested. Aflatoxin is known to cause serious cancer diseases in human.

The microbial deterioration in tomato fruit causes reduction in market value and nutritional qualities and at times rendered the fruits unfit for consumption. This is due to contamination with mycotoxin that produce aflatoxin in human, following inhalation or ingestion and resulting in food poisoning. Tomato fruits being succulent about 80% water content, low pH, highly rich nutrient element and sugars, served as suitable medium for microbial growth. The major aflatoxin that can be isolated from contaminated tomato are B_1, B_2, G_1, G_2) (Ayeni *et al.,* 2020). The presence of aflatoxin (*Aspergillus* spp) in the tomatoes is an indication of possible health hazard, its causes food intoxication and food infection (Muhammad *et al.,* 2004).

Tomatoes are exceptionally helpless to resist the parasitic infection in the field, amid transportation, preparing, and storage (Mariutti and Soares, 2009). Tomato is a sensitive crop with delicate skin, exceedingly powerless to organisms' defilement through harmed skin or harmed tissues in the field, during transportation, processing, and through storage. Tomatoes are soft skin fruits highly susceptible to fungi contamination, mainly through injured skin or damaged tissues. Strains from several fungi species are known to produce toxins on tomatoes during field production or storage. Hence, this study aims to assess the microbiological safety in the consumption of sachet tomato paste.

MATERIALS AND METHODS

Sample collection

Twenty samples of tomato paste comprising ten brands were randomly purchased from Bodija Market and Sango Market in Ibadan Oyo State Nigeria.

Isolation of fungi

The pour plate method was used. One milliliter of the serially-diluted sample (10^3) was dispensed into a conical

flask containing sterile sabouraud dextrose agar (SDA) and two percent chloramphenicol to inhibit bacterial growth. The contents were properly mixed and dispensed aseptically into sterile petri-dishes. Incubation was carried out in an inverted position at 28°C for five days. The colonies that developed were counted and subcultured repeatedly on sabouraud dextrose agar plates to obtain pure cultures.

Identification of fungi

A drop of lactophenol cotton blue stain was placed on a clean slide and with the aid of a mounted needle, a small portion of the mycelium from the fungal cultures was removed and placed in the drop of the stain. The mycelium was spread very well on the slide with the aid of the two mounted needles and a cover slip was gently lowered on it. The slide was then examined under the microscope. The observation was done at high power objective (×40) of the microscope. Morphological characteristics of the fungi such as type of hyphae and asexual reproductive structure were observed. The isolated fungi were identified on the basis of their micro and macro- morphological characteristics using standard taxonomic key used previously (Samson *et al*., 2010; Pitt, 1979; Pitt and Hocking, 2009; Raper and Fennel, 1965; Ellis *et al*., 2007).

Proximate composition

Moisture content

Moisture content was measured using air-oven following official methods of Association of Official Analytical Chemists. 2.0 g of each sample was dried till constant weight in hot air over operated at 105°C, firstly for 3 hours. Each time, the samples were cooled in a desiccator before weighing and re-dried until constant weight was obtained. The percentage of moisture content was calculated.

Ash content

A dry ashing method was used to determine the ash content. 2 g of each sample was incinerated in a furnace at 550°C. The remaining inorganic material was cooled and weighed and the percentage ash content was calculated.

Crude fiber

2 g of the defatted and dried sample was weighed and added into a round bottom flask containing 200 mL of boiling sulphuric acid solution. This was connected to a condenser and brought to boil within a minute. Refluxing was done for 30 minutes with periodic swirling of the flask to remove particles adhering to the sides. This was filtered within 10 mins using a pre heated Buchner flask. The residue on the filter paper was washed with boiling water and the residue was transferred back into a clean round bottom flask containing 200 mL of boiling Sodium hydroxide and the refluxing was again carried out for 30 minutes. The hydrolyzed mixture (after letting it rest for 1 minute) was filtered within 10 minutes in a preheated Buchner flask. The residue was washed with boiling water, with the HCl solution and then again with boiling water and finally with petroleum ether. The residue was then transferred into a pre-weighed crucible and oven dried at 105°C till constant weight and the weight was recorded. The crucible was immediately transferred into a muffle furnace operated at 550°C for 3 hours. Left to cool in a desiccator and weighed again.

Determination of crude fat content using Soxhlet extractor

2.0 g of each sample was added to the pre-weighed filter paper and was dipped inside the soxhlet extractor, which was fitted up with the reflux condenser and a flat bottom flask. The flask was filled to about ¾ of its volume with n-hexane. This was heated using heating mantle and allowed to reflux for 6 hours. After the extraction is completed, the wrapped filter paper containing the sample was dried in the oven at a temperature for one 1 hour and was cooled in the desiccator. Weight of the sample was determined after extraction.

Crude protein

1 g of the sample was placed in the Kjeldahl flask; a copper sulphate catalyst tablet and 10 ml concentrated sulphuric acid was added. The flask was placed in a digester, boiled until a clear solution is formed. This was left to cool and gradually approximately 90 ml distilled, de-ionized water was added. One glass bead and 80 ml of 40% sodium hydroxide solution, was added and the flask was connected to the distillation unit.

0.5 g of the sample was weighed into 100 ml digestion tube. 5 ml of concentrated Nitric acid was added, the sample was then digested at a temperature of 135°C for 1 hour 30 minutes. It was allowed to cool and filtered into another 25 ml flask; it was then made up to mark with distilled water. This was repeated for all samples. The samples were read on AAS [using BUCK 200 AAS (AOAC, 1998)].

Mineral determination: sodium (Na), potassium (K), calcium (Ca), and magnesium (Mg), and seven trace elements, including iron (Fe), and manganese (Mn) were

determined in the samples using an atomic absorption spectrophotometer (AA-7000, Shimadzu Corpo- ration, Kyoto, Japan) coupled with an autosampler ASC 7000. The elements were measured using a direct absorption technique according to the standard guidelines of the manufacturer.

Aflatoxin determination: Aflatoxin analysis

Aflatoxin content of the tomato samples were determined using enzyme linked immunosorbent assay kit (ELIZA). The tomato sachets were analysed for aflatoxins at Animal care lab along Ogere, Lagos State. The samples were prepared for extraction in which 20 ml of the sample was mixed with 100 ml of 70/30v/v methanol/water and vigorously mixed.

Filtration was done and the filtrate was dispensed into the dilution wells of the kit. This was mixed and about 100 ul was transferred from the dilution wells into antibody coated wells, incubated at room temperature for 15 minutes. The micro wells strips were washed and the strips were read with ELISA reader using 450 nm filter and 630 nm differential filter.

RESULTS

The fungi isolated from this study belongs to the genera *Aspergillus*, *Fusarium*, *Penicillium* and *Neurospora* as shown in Table 1. *Aspergillus* species have the highest frequency of occurrence of 55%, followed by *Fusarium* with 22.5% occurrence, *Penicillium* species with 10% occurrence, *Neurospora* species with 12.5% occurrence. The result of the proximate composition is shown in Table 2. The moisture content of the samples ranged from 68 to 75%, the ash content of the samples ranged from 1.11 to 3.69%, the crude fibre content ranged from 0.47 to 2.45%, the crude protein ranged from 1.45 to 5.0%, crude fat ranged from 0.04 to 0.8% and the carbohydrate content ranged from 16.9 to 25.45%. Table 3 shows the mineral analysis of the tomato sachet samples. Sodium content ranged from 78.3 to 107 mg/100g, potassium content ranged from 123 to 169 mg/100g, calcium content ranged from 35 to 78 mg/100g. Magnesium content ranged from 53 to 96 mg/100g, manganese content ranged from 0.56 to 1.21 mg/100g, iron content ranged from 3.75 to 6.91mg/100g. Table 4 shows the concentration of aflatoxin in the tomato sachet, aflatoxin content ranged from 3 to 29 ppb.

DISCUSSION

Fungi are major cause of reduction in agricultural yields and may contaminate food before, during and after harvest. Damage due to mycotoxins–producing fungi (secondary metabolite) goes beyond damage to fruits and may seriously compromise the quality of processed products, posing risks to food safety. In this study, fungi namely *Aspergillus flavus*, *Aspergillus niger*, *Neurospora* spp, *Fusarium* spp and *Penicillium* spp were isolated. *Aspergillus* spp had the highest frequency of occurrence of 55% followed by *Fusarium* spp with percentage occurrence of 22.5%, *Penicillium* spp (10%) and *Neurospor*a spp with percentage occurrence to be 12%.

Table 1. Fungi isolates and percentage occurrence

Fungi	Occurrence	% occurrence
Aspergillus spp	22	55
Fusarium spp	9	22.5
Pencillium spp	4	10
Neurospora spp	5	12.5
Total	40	100

The result presented on proximate analysis indicates that the highest moisture content 75.70% was obtained from sample 13 (G paste) and the lowest moisture content of 68.15% was obtained from sample 11 (B 2). Various levels of moisture content for tomato paste have been previously reported. The result obtained from this work is in conformity with that of Christabel (2018) who reported the moisture content in the range of 73.93 to 71.61%. This moisture level also confirms with the moisture content of commercial tomato paste reported by Abdullahi *et al*. (2016). The moisture content of almost all the tomato paste samples were above 70% comparable to the results reported by Abdullahi *et al*. (2016). Fresh tomato fruit has a high moisture content of 95% and could contribute to the high moisture content of its products. Variety used and method of processing as reported by USDA (2009), could be the reason why G tomato paste has higher moisture content than the other tomato samples. Products having a moisture content has minimum shelf life stability (Ayub *et al*., 2003).

The crude ash content obtained from this analysis report shows that maximum ash content was found in sample 10 (3.60%) tomato paste sample E and minimum in sample 1(1.11%) B tomato paste. The variations in ash content of the samples may be attributed to the formulation of each manufacturer. The ash contents of tomato paste in this study are lower than the 3.30 to 5.70% reported for tomato paste by Christabel (2018) but slightly conforms with the results of tomato paste which ranges within 0.85 to 3.83% in fresh and canned tomato respectively was reported by Abdullahi *et al.* (2016). Difference in ash content obtained could be due to geographical differences and also their chemical composition. The result of this analysis differs from that of Muhammad *et al*. (2004) who reported the highest ash content in tomato cultivars to be 0.18% and

Table 2. Proximate composition of retailed tomato pastes in Ibadan metropolis.

Samples	Moisture (%)	Ash Content (%)	Crude fiber (%)	Crude protein (%)	Fat (%)	Carbohydrate (%)
Sample 1	74.24±0.04	1.11±0.00	1.28±0.01	1.98±0.01	0.52±0.00	20.87±0.00
Sample 2	73.85±0.04	2.48±0.01	0.47±0.01	2.29±0.01	0.37±0.00	20.54±0.05
Sample 3	68.40±0.02	1.20±0.01	2.48±0.01	2.80±0.03	0.50±0.00	24.62±0.01
Sample 4	73.61±0.05	2.41±0.00	0.79±0.00	3.77±0.02	0.04±0.01	19.35±0.05
Sample 5	70.27±0.00	3.11±0.02	2.26±0.00	4.52±0.00	0.39±0.02	19.44±0.01
Sample 6	74.40±0.03	1.61±0.01	1.55±0.02	3.28±0.00	0.05±0.01	19.11±0.01
Sample 7	74.00±0.02	1.69±0.02	1.28±0.02	2.48±0.00	0.56±0.01	20.02±0.03
Sample 8	75.18±0.02	1.37±0.00	1.44±0.02	3.30±0.04	0.36±0.00	18.31±0.05
Sample 9	74.31±0.01	3.42±0.01	2.46±0.02	2.86±0.00	0.04±0.01	16.91±0.04
Sample 10	70.33±0.02	3.60±0.01	1.75±0.02	5.00±0.00	0.05±0.00	19.26±0.04
Sample 11	68.15±0.03	1.50±0.00	1.00±0.00	3.20±0.04	0.69±0.02	25.45±0.05
Sample 12	73.15±0.03	2.28±0.01	1.14±0.01	3.41±0.02	0.37±0.00	19.64±0.05
Sample 13	75.70±0.01	1.83±0.02	1.60±0.03	2.76±0.03	0.80±0.02	17.33±0.01
Sample 14	75.21±0.03	1.43±0.00	2.05±0.00	1.45±0.00	0.49±0.04	19.38±0.02
Sample 15	74.02±0.02	1.50±0.00	2.25±0.03	3.52±0.04	0.68±0.00	18.04±0.04

The data are means value +_ standard deviation (SD) of triplicate samples.

Table 3. Mineral analysis (Na, k, Ca, mg, Mn & Fe) content in tomato paste samples.

S/No	Sample codes	Na(mg/100g)	K(mg/100g)	Ca(mg/100)	Mg(mg/100g)	Mn(mg/100g)	Fe(mg/100g)
1	A1	89.4±0.14	133.3±0.35	42.7±0.35	62.3±0.14	0.67±0.021	4.13±0.028
2	A2	89.2±0.14	132.8±0.28	43.2±0.35	61.6±0.14	0.64±0.021	4.09±0.028
3	B1	78.3±0.28	123.6±0.49	39.8±0.28	54.4±0.00	0.59±0.014	3.88±0.035
4	B2	78.7±0.35	124.3±0.49	40.2±0.28	53.7±0.14	0.57±0.021	3.93±0.035
5	C1	97.1±0.21	146.2±0.35	56.7±0.28	77.3±0.28	0.93±0.028	5.62±0.028
6	C2	96.8±0.28	145.7±0.28	57.1±0.28	76.9±0.21	0.89±0.028	5.58±0.028
7	D1	102.6±0.49	164.8±0.42	72.4±0.99	91.8±0.00	1.07±0.021	6.29±0.021
8	D2	103.3±0.42	165.4±0.35	73.8±0.42	92.3±0.00	1.04±0.014	6.32±0.021
9	E1	86.7±0.35	132.1±0.42	41.6±0.56	59.6±0.14	0.84±0.014	4.02±0.021
10	E2	86.2±0.28	131.5±0.42	40.8±0.49	58.7±0.21	0.82±0.014	4.05±0.021
11	F1	105.5±0.63	168.8±0.42	77.7±0.42	95.8±0.28	1.16±0.035	6.71±0.028
12	F2	106.4±0.56	169.4±0.42	78.3±0.42	96.2±0.21	1.21±0.014	6.67±0.028
13	G1	107.8±0.28	167.2±0.49	76.5±0.49	94.4±0.21	1.13±0.014	6.86±0.035
14	G2	108.2±0.28	166.5±0.42	77.2±0.49	93.6±0.14	1.11±0.014	6.91±0.028
15	H1	90.8±0.28	163.6±0.56	71.3±0.35	90.7±0.35	1.03±0.014	6.15±0.021
16	H2	91.2±0.28	162.8±0.63	70.8±0.35	91.2±0.35	1.01±0.014	6.12±0.021
17	I1	72.6±0.56	126.4±0.49	36.2±0.28	55.3±0.00	0.58±0.014	3.75±0.028
18	I2	73.4±0.63	125.7±0.42	35.8±0.28	54.7±0.00	0.56±0.014	3.79±0.035
19	J1	91.7±0.42	135.3±0.49	45.2±0.21	63.6±0.00	0.69±0.014	5.23±0.035
20	J2	92.3±0.42	134.6±0.49	44.9±0.21	62.8±0.14	0.71±0.014	5.18±0.028

the lowest ash content to be 0.14% which are closely in agreement with the results of Adubofuor *et al.* (2010) and Sulieman *et al.* (2011) who reported values of tomato cultivars ranging from 0.2 - 0.4%. According to Nielsen (2002), who evaluated the nutritional values of some cultivars and observed that the tomato paste containing the highest ash content hence contain the highest mineral. In a proximate analysis results reported by Anandsynal *et al.* (2018) shows that the maximum ash content in tomato sauce and ketchup is 1.43% and the minimum is 0.10%, the lower ash content indicates low fruit content in the product.

Table 4. Aflatoxin test results in tomato paste samples.

S/N	Aflatoxin standards	Opticaldensity (450 nm)	Total aflatoxin concentration in the sample (ppb)
Aflatoxin standards			
1	0	1.531	-
2	4	1.172	-
3	10	0.714	-
4	20	0.305	-
5	40	0.206	-
Test samples			
1	B 1	1.348	23
2	B 2	1.598	11
3	V 1	1.487	3
4	V 2	1.630	10
5	M 1	1.353	20
6	M 2	1.690	5
7	S 1	1.351	20
8	S 2	1.351	25
9	A 1	1.279	29
10	A 2	1.669	9
11	G 1	1.328	22
12	G 2	1.550	12
13	DR 1	1.324	25
14	DR 2	1.475	18
15	TT 1	1.350	20
16	TT2	1.679	3
17	RG 1	1.641	9
18	RG 2	1.630	10
19	E1	1.310	24
20	E2	1.649	8

The fibre content reported is slightly in accordance with the report of Onifade *et al.* (2013), who reported the fibre content of different tomato cultivar within the range of 0.70% and 3.25%. The result of this analysis are within the range of Mohammed *et al*. (2017) who obtained 1.25% as the highest fibre content and 1.12% as the lowest fibre content which also correspond with that of Alvi *et al.* (2003), Adebooye *et al.* (2006) and Olaniyi *et al.* (2010). However, in an analysis carried out by Christabel (2018), 10.94% was recorded for the lowest fibre content whilst the highest fibre content being 17.38%. The result differs from the results gotten from this study. High-fibre is nutritionally beneficial since it promotes health and aids digestion of food, hence tomato paste with relatively high fibre content could provide health benefits to its consumer.

The crude protein analysis result shows that maximum crude protein is found in sample 10(E) 5.00% and the minimum is found in sample 14(DR) 1.45%. There was a significance difference between the crude protein of the tomato paste. The result of this analysis is very different from that of Christabel (2018) who recorded the crude protein as 0.58% as the highest and 0.30% as the lowest. The difference in crude protein content could be attributed to the varietal differences as well as differences in processing conditions of the pastes. In an analysis reported by Mohammed *et al.* (2017), they obtained 2.60% as the highest crude protein and 2.23% as the lowest to value of crude protein which are relatively lower than the result of this analysis. However, the results of this analysis is slightly similar to that of Abdullahi *et al.* (2016) who recorded 4.83% as the highest crude protein in fresh tomato and 1.00% as the lowest in canned tomato. High water content of fresh tomato used in processing might result in low level of protein. Anandsynal *et al.* (2018) whose crude protein content in tomato sauce and ketchup range from 0.17 to 0.11% which is lower to the result of this analysis. Protein is necessary for building the structural components of human body, such as muscles and organs *(*Robert *et al*., 2006). Protein deficiency causes growth retardation, muscle wasting, oedema, abnormal

swelling of the belly and collection of fluids in the body (Mounts, 2000).

Carbohydrate content ranges from 25.45% which is the highest value found in sample 11 (B 2) to 16.91% as the lowest value found in sample 9 (RG). In an analysis results reported by Abdullahi *et al*. (2016) shows the carbohydrate content in fresh tomato to be between 15.18 to 2.52% which differs from the result of this analysis. Ahmed *et al.* (2020) recorded different but slightly similar results, 21.77% as the highest content and 3.70% as the lowest carbohydrate content in dried and blanched tomato respectively. Carbohydrate content which ranges from 69.84 to 91.43% was reported in industrial tomato paste and fresh tomato respectively by Yaroson *et al.* (2018) which shows a higher value than that of these findings and also higher than that of Anandsynal *et al*. (2018) who recorded carbohydrate content to fall within the range of 69.38 and 37.16%. However, the result of this findings is significantly higher than the result recorded by Christabel (2018) who recorded the carbohydrate content value to be 13.44% and 2.57% in tomato paste and reconstituted tomato powder, respectively.

Crude fat of this analysis ranges from 0.80 to 0.04%, the highest fat content is found in sample 13 (G) and the lowest is found in sample 4 (S) and sample 9(RG). Also Ahmed *et al*. (2020) reported the value of 2.36 to 8.34% as crude fat in tomatoes which is higher than the value of this findings. Christabel (2018) reported the value of crude fat of tomato to range between 0.42 to 0.62% which is slightly similar to the results of this findings. The lower crude fat contents agree with the fact that tomato fruit is a low-fat fruit (0.19 -0.51%) as reported by Badejo *et al*. (2016). The low-fat content makes the tomato paste nutritional healthy for low-fat diets. The results of these findings is contrary to Yaroson *et al*. (2018) who reported 6.70 to 3.30% as the value of crude fat content in industrial tomato paste and fresh tomato respectively but their result is similar to Abdullahi *et al.* (2016). These differences might be attributed to the type of tomato used by the production company to make the tomato paste. Abdullahi *et al*. (2016) reported crude fat value of canned tomato paste which ranges from 0.62 to 0.14% which is slightly similar to the results of this findings. However, similar value is reported by Anandsynal *et al*. (2018) who reported the value of crude fat of tomato sauce and ketchup to be between 0.03 to 0.75%. Usually, fat content of different fruits is not greater than 1%.

The sodium content of the samples ranged from 72 -108 mg/100g. Sodium controls fluid balance in our bodies and maintain blood volume and blood pressure and eating too much sodium may raise blood pressure and cause fluid retention, which could lead to swelling of the legs and feet or other health issues. Sodium deficiency is extremely rare. The kidneys conserve and release sodium as needed to maintain fluid balance. The amount of sodium lost in a day, in the form of urine and sweat, equals the amount of sodium eaten in the diet. The potassium content ranged from 124 to 169 mg/100g. Potassium is commonly found in a variety of unrefined foods, especially fruits and vegetables e.g banana, tomato, cherry e.t.c. Increased potassium intake reduced systolic and diastolic blood pressure in adults. Most people get potassium via a healthy diet that is low in sodium and full of fruits and vegetables. According to World Health Organization (WHO, 1996), the permissible limit for potassium intake for adult is 3400 mg per day for men and 2600 mg for women.

The calcium content in sample ranged from 36.2 to 78.0 mg/100g. Calcium is one of the most abundant minerals in body. About 99% of the calcium in the body is in the bones and teeth and 1% is in the blood, muscles, and other soft tissues (such as the nerves, organs, etc.). This 1% plays a major role in our health- it acts in normal muscle contraction and relaxation, nerve functioning, blood clotting, blood pressure and immune defenses. Excessively high levels of calcium in the blood known as hypercalcemia impair kidney function. However, hypercalcemia is rare. The recommended daily intake for adults is 1000 mg. Teens and older adults need 1200 mg (Rodríguez-Rodríguez *et al*., 2010).

The magnesium content of the samples ranged from 53.7 to 91.8 mg/100. Magnesium helps boast energy, reduce inflammation and support immunity and it is considered minor nutrient, because it plays a significant role in the overall health and essential to every function and tissue in the body. The permissible limit of magnesium in food intake is 400 to 420 mg per day for men and dietary allowance of magnesium for adult women is 310 to 320 mg per day. The manganese content ranged from 0.56 to 1.21 mg/100g. Manganese is an essential trace element that is naturally present in many foods and available as a dietary supplement. Manganese is a cofactor for many enzymes, including manganese superoxide dismutase, arginase, and pyruvate carboxylase. Through the action of these enzymes, manganese is involved in amino acid, cholesterol, glucose, and carbohydrate metabolism; reactive oxygen species scavenging; bone formation; reproduction; and immune response. Manganese also plays a role in blood clotting and hemostasis in conjunction with vitamin K.

The iron content ranged from 3.75 to 6.8 mg/100g. Iron is an important element in human and plays a significant role in the formation of hemoglobin, oxygen transfer in the human body. The permissible limit of iron intake for human body by WHO is 0.80 mg/100kg (WHO, 1996).

Conclusion and Recommendation

Conclusively, sachet tomato paste is low in fat, high in moisture, moderate in carbohydrate and protein. However, it was found to be contaminated with fungi, and aflatoxins in varying concentrations. Hence the need for food

agencies to properly put in place measures to enhance quality assurance of sachet tomato paste.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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