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Research Article

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Chromatographic Determination of Selected Preservatives In Canned Foods Sold In Onitsha, Anambra State, Nigeria

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Abstract

This study comparatively evaluated the performance of High-Performance Liquid Chromatography (HPLC) and Gas Chromatography-Mass Spectrometry (GC-MS) for the determination of selected preservatives in canned foods sold in Onitsha, Anambra State, Nigeria. 30 samples of Five brands of canned foods from two different production batches were subjected to solid-liquid extraction and analyzed in triplicate for benzoic acid, sorbic acid and related preservatives using both methods under optimized conditions. Method validation parameters including linearity, Limit of Detection (LOD), Limit of Quantification (LOQ), recovery and precision where compared. Both methods showed good linearity (R2 > 0.99). HPLC demonstrated lower LOD (0.001-0.01 mg/kg) and LOQ (0.003-0.03 mg/kg) compared to GC-MS (LOD 0.05-1.2 mg/kg ; LOQ 0.15-3.6 mg/kg), with better recovery (HPLC: 94.2-104.1% vs GC-MS: 78.5-130.2%) and lower %RSD (< 3.5% vs < 12.8%).

HPLC quantified preservatives at 0.002-2.52 mg/kg, within FAO/WHO Codex Alimentarius limits. GC-MS gave significantly higher values (2500-104200 mg/kg) with significance difference between methods ($p<0.05$, Two-Way ANOVA), indicating matrix interference. The health risk assessment based on GC-MS data showed HQ > 1. This study concludes that HPLC is more selective, sensitive and reliable for non-volatile preservatives like benzoates and sorbates in complex canned food matrices, while GC-MS without derivatization is prone to false positives and overestimation. All the fifteen samples at Ose analyzed using HPLC were all within limits set by WHO/FAO and NAFDAC and poses no potential non-carcinogenic health risk while the fifteen samples analyzed with GC-MS were all above the permissible limits set by WHO/FAO and NAFDAC and posses high potential non-carcinogenic health risk.

Keywords: Method Comparison, HPLC, GC-MS, Preservatives, Method Validation, Canned Foods

1. Introduction

Food preservation is a cornerstone of modern food systems, aimed at extending the shelf life of products, maintaining their nutritional quality, and ensuring safety for consumers [1]. One of the most widely adopted preservation techniques is canning, which involves sealing food in air-tight containers and applying heat to destroy microorganisms that cause spoilage [2]. To further enhance stability and consumer appeal, chemical preservatives are often added to inhibit microbial growth, prevent oxidation, and retain desirable attributes like flavour and colour [3].

While these preservatives are generally recognized as safe (GRAS) by regulatory agencies when used within prescribed limits, their widespread use and potential for excessive consumption have raised significant concerns among consumers, health professionals, and regulatory bodies. Research has shown that some food preservatives can weaken heart tissues and increase the risk of heart damage [4]. Moreover, certain preservatives, such as nitrites and nitrates, can transform into carcinogenic nitrosamines, posing a significant risk to human health [5]. Excessive sulphite consumption may also trigger respiratory problems in sensitive individuals, while other preservatives have been linked to allergic

reactions and gastrointestinal disturbances [6].

Onitsha, a major commercial hub in Anambra State, serves as a central marketplace where a vast variety of canned foods are sold. The widespread availability of these products underscores the need for rigorous quality control and monitoring. Regulatory bodies, such as the National Agency for Food and Drug Administration and Control (NAFDAC), have established comprehensive guidelines on food additives, including the Food Additives Regulations, 2021 (NAFDAC, 2021) and the Pre-Packaged Food (Labelling) Regulations, 2022 (NAFDAC, 2022), which stipulate the permitted types and maximum permissible levels of preservatives [7,8]. Similarly, international bodies like the Codex Alimentarius Commission and the World Health Organization (WHO) have established standards and encouraged national authorities to monitor and ensure compliance with legislation governing food preservatives [9,10]. The core problem, therefore, is the lack of accurate, empirical data on the levels of preservatives in canned foods, which prevents a proper assessment of food safety compliance and the associated health risks to the public.

This study aims to address this critical issue by scientifically evaluating preservative concentrations, levels and comparing them against established safety standards.

2. Materials and Methods

2.1. Materials

2.1.1. Sample Collection

A total of 30 samples was collected for this study which comprises of five canned food types (sweet corn, Hot dog, Tin tomatoes, corn beef and mayonnaise) of food categories vegetables, meats and condiments. The samples were randomly selected in triplicates from two different production batches in five different shops to capture variability. The samples were labelled from A-E. Tin tomatoes-A, Chicken sausage-B, Corn beef-C, Sweet corn-D and Mayonnaise E.

2.1.2. Standards and Reagents

Methanol (CH3OH), distilled water, Acetonitrile (CH3CN), Hexane(C6H14), Hydrochloric acid (HCl), Dichloromethane (DCM) CH2Cl2, (N, O-Bis(trimethylsilyl)trifluoroacetamide) BSTFA, (Trimethylchlorosilane) TMCS, pyridine, Calcium propionate standard, Potassium sorbate standard, Sodium benzoate standard, propionic acid standard, Acetic acid standard.

2.2. Methods

2.2.1. Study Area

The study was conducted in Onitsha, Anambra State, Nigeria, focusing on a major market (Ose Market and Ochanja Market) known for diverse canned foods. Onitsha market provides a representative selection of food brands and food types, ideal for assessing preservative exposure.

2.2.2. Sample Preparation and Extraction

2.2.2.1. For GC-MS

Using weighing balance,10g of each of the samples were transferred in 100ml of beaker. With measuring cylinder, 100ml of 98% Methanol was added to the crushed samples for extraction. The samples were mixed with the solvent and placed in a sonicator for 2 hours and was allowed to cool for 24hours for extraction of the preservatives to be completed. It was filtered using vacuum pump filtration system to collect the extract with the solvent from the sample residue. The mixture of the extract and solvent were concentrated over a water bath to remove the solvent from the sample residue. The extract was dissolved in Dichloromethane(DCM) and diluted with DCM to 100ml and then stored in sample vials ready for analysis on GCMS machine [11].

2.2.3. For derivatization of non-volatile compounds

The sample extract was evaporated to complete dryness using a rotary evaporator (to ensure complete removal of solvent and moisture, which quenches silylation reagents). The dried samples were then redissolved in 100µL pyridine and 100µL (N,O-Bis(trimethylsilyl)trifluoroacetamide) BSTFA + 1% (Trimethylchlorosilane) TMCS was added. The mixture was sealed in sample vials and incubated at 700C for 30 minutes, ready for analysis on the GC-MS machine [12].

2.2.4. For HPLC

The samples were prepared by mixing 10g of the sample with 50ml of HPLC-grade water, then the mixture transferred into 100ml volumetric flask, the volume was completed to 100ml using HPLC-grade water and placed in the ultrasonic bath for 15 minutes then the final solution was filtered through a 0.45□m membrane filter paper and degassed by ultrasonification. The samples were dissolved in methanol and after which they were injected into the system prior to determination by HPLC [13].

2.2.5. Determination with GC-MS

Quantitative determination of preservatives was carried out using Varian Gas Chromatography-Mass Spectrometry 4000/3800 gas chromatography (Agilent Technology, Palo Alto, CA). Separation was achieved on an HP-1MS (cross linked PH ME Siloxane) 19091S-933 capillary column (30 m × 0.25 mm, 0.25µm film thickness). The GC oven temperature was programmed as follows: initial temperature of 70 °C held for 1min first ramped to at 5 °C/min 180 °C second ramp at 10 °C/min to 280 °C Final temperature at 10°C/min to 300 °C. Nitrogen gas was used as the carrier gas at a constant flow of 1.2ml/min. Injector and detector temperatures were set at 250 °C. Injection volume will be 1.0µL in spitless mode. The MS will be operated in selected ion monitoring (SIM) mode for target PAHs. The ion source temperature and interface temperature are 200 °C and 250 °C respectively. Quantification will be achieved using calibration data prepared from certified preservative standards which contain the preservatives specified by EPA. (Wise, Sander, and Schantz, 2015).

2.2.6. Determination with HPLC

The mobile phase composed of methanol and phosphate buffer (pH 7.30) (20:80), V/V is used. Stationary phase used was C18 (Octadecylsilane) 250mm × 4.6mm,5µm at a column temperature of 400C. The optimal wavelength for detection was set at 225nm.

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The chromatographic separation was achieved with isocratic elution (2.5µL of sample are injected into chromatographic system) at a flow rate of 1.0-1.2ml/min [14].

The chromatographic analysis was carried out with Agilent 1100 Infinity Rapid Resolution Liquid Chromatography (RRLC) system equipped with vacuum degasser(G1322A), binary pump(G1312B), auto sampler (Gi329B), a thermostat column compartment (G1316A), UV/Vis diode array detector(G1316B) and ChemStation software. For optimization of the method following three analytical columns were used: Hypersil ODS (25CM × 0.46cm; 5µm), LiChrospher 60RP-select B (12.5cm × 0.4cm; 5 µm) and HS (High speed) .

2.2.7. Method Validation and Quality Control

To ensure the reliabilty and accuracy of results, strict quality assurance and quality control measures will be implemented throughout the process. Method blanks,matrix spikes and triplicate samples was analyzed with each batch to monitor accuracy and precision. Instrument caliberation will be performed using five-point, standard curves (0.1- 10µg/L), with correlation coefficients(R) maintained above 0.995. Surrogate recoveries will be closely monitored and data will be accepted only within the recovery range of 60-120%. Limits of detection (LODs) will be calculated as three times the signal-to-noise ratio, ranging between 0.01-0.05 ng/g, while limits of quantification (LOQs) will be established as ten times the signal-to-noise ratio, ranging between 0.03-0.15 ng/g. To prevent cross-contamination, all glassware will be baked at 4500C for 6 hours prior to use. In addition, both field blanks and solvent blanks will be incorporated into the workflow to assess and control background contamination [15].

2.2.8. Data analysis

Descriptive statistics were used to represent data as mean□ standard deviation. One-way analysis of variance (ANOVA) was carried out to compare the preservative levels in canned foods. Turkey's test was used to determine significance for mean effects on preservatives concentrations.

2.2.9. Health Risk Assessment

The health risk assessment in this study evaluated the potential risks associated with dietary exposure to preservatives in selected canned foods. This include:

The hazard quotient (HQ), a non-cancer risk measure for systemic toxicity was estimated using Eq. 1

$$HQ = \frac{EDI}{ADI} \quad (1)$$

HQ = Hazard Quotient
ADI = Acceptable Daily Intake

Parameter	Symbol	Adult standard	Child standard	Source basis
Body weight	BW	70kg	15kg	U.S EPA, 2011 [16]
Exposure duration (non-cancer)	ED	30 years	6 years	U.S. EPA, 2011
Exposure duration (Cancer)	ED	70 years	20 years	U.S. EPA, 2011
Exposure frequency	EF	365days/year	365days/year	Daily dietary intake
Ingestion rate	IR	0.050kg	0.025kg	U.S. EPA,2011
Ingestion rate(condiments)	IR	0.015kg	0.0075kg	U.S. EPA, 2011
Averaging time (non cancer)	AT	10,950	2,190	(ED × 365)

Table 1: Exposure Parameters

The hazard index (HI) used to evaluate the overall non-cancerous health risk is the sum of the hazard quotients.

3. Results and Discussion

Preservatives in canned foods were determined using solid-liquid extraction method for concentration of the samples analyzed with Gas Chromatography-Mass Spectrometer (GC-MS) and High-Performance Liquid Chromatography. This study was carried out to determine the concentration of preservatives that are beyond permissible limits.

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Samples	Calcium propionate (Mg/kg)	Sodium benzoate (Mg/kg)	Potassium sorbate (Mg/kg)	Propionic acid (Mg/kg)	Acetic acid (Mg/kg)
A	0.086 ± 0.005	0.138 ± 0.019	0.029 ± 0.006	0.128 ± 0.008	0.026 ± 0.0001
B	0.330 ± 0.006	0.634 ± 0.009	0.210 ± 0.007	ND	0.026 ± 0.002
C	0.128 ± 0.005	0.932 ± 0.01	0.035 ± 0.001	0.603 ± 0.004	0.002 ± 0.005
D	0.025 ± 0.001	0.637 ± 0.007	0.251 ± 0.10	ND	0.003 ± 0.0001
E	0.625 ± 0.006	2.233 ± 0.011	ND	0.119 ± 0.0029	0.013 ± 0.0005
WHO/FAO	1000	1000	2000	3000	GMP
NAFDAC	1000	1000	2000	3000	GMP

Table 2: Preservative Levels of Canned Foods at OSE Market

ND: Not Detected

The results in table 2 above shows the concentrations of preservatives in the analysis of canned foods purchased from different vendors in Ose Market Onitsha.

- **Calcium Propionate:** At Ose, the concentration of calcium propionate in sample E (mayonnaise) analyzed ranged from 0.025 ± 0.001mg/kg to 0.625 ± 0.006mg/kg. These values are within the permissible limits set by WHO/FAO and NAFDAC as shown in the table 2 above. Chutima and Surin, 2016 analyzed 22 samples using HPLC and 19/22 samples contained calcium propionate are above 2000mg/kg. The ANOVA results shows that calculated F-value is bigger than the F-critical and the P-value 0.0001 is far below the standard (0.05), we reject the null hypothesis because there is statistical difference between the concentration of calcium propionate preservatives in all Canned foods purchased at Ose. Turkey HSD Post Hoc analysis shows that sample E (0.625) was significantly higher followed by Chicken Sausage B (0.330), C corn beef (0.128), A (Tin tomato) 0.086 and D, sweet corn (0.025).

- **Sodium Benzoate:** The concentration of sodium benzoate analyzed in sample E (Mayonnaise) at Ose, ranged from 0.138 ± 0.019mg/kg to 2.233 ± 0.011mg/kg. These values are within the permissible limits set by WHO/FAO and NAFDAC as shown in the table 2. Magomya et al., 2020 in their analysis of concentration of sodium benzoate, seven samples were found with concentrations above permissible limits. Another research on sodium benzoates by (Azuma et al., 2020) reveals that 16% of 38 analyzed soft drink samples exceeded safe sodium benzoate limits [17]. The ANOVA results shows that calculated F-value is bigger than the F-critical and the P-value 0.0001 is far below the standard (0.05), we reject the null hypothesis because there is statistical difference between the concentration of sodium benzoate preservatives in all Canned foods purchased at Ose, Turkey HSD Post Hoc analysis shows that Mayonnaise (2.233) was significantly higher followed by corn beef, sweet corn and chicken sausage, then tin tomato.

- **Potassium Sorbate:** The concentration of potassium sorbate analyzed in sample D (Sweet corn) at Ose ranged from 0.029 ± 0.006mg/kg to 0.251 ± 0.01mg/kg. The values are within the permissible limits set by WHO/FAO and NAFDAC as shown in Table 2. This agrees with work done by (Magomya *et al*., 2020) all the obtained concentrations for potassium sorbate were within the acceptable limits in the concentrations between 1.36- 158mg/l [18]. The ANOVA results reveals that the calculated F-value is significantly larger than the critical value and the P-value (0.0001) is below the standard (0.05), we reject null hypothesis because there is a statistically significant difference between the concentrations of the preservatives used. Turkey HSD Post Hoc analysis shows that potassium sorbate in sweet corn was significantly higher followed by chicken sausage, sweet corn and then tin tomato. It was not detected in mayonnaise.

- **Propionic Acid:** The concentration for propionic acid at Ose ranged from 0.119 ± 0.029mg/kg to 0.603 ± 0.004mg/kg in mayonnaise, tin tomato and corn beef and there was no detectable propionic acid in chicken sausage and sweet corn. The values are within the permissible limits set by WHO/FAO and NAFDAC as shown in the table 2 above. The ANOVA results shows that the F-calculated is greater than the F-critical and the P-value (0.0001) is below the standard (0.05), we reject the null hypothesis because there is a significant difference between the propionic acid preservative in all the canned foods purchased at Ose. Turkey HSD Post Hoc analysis showed that the propionic acid in corn beef is statistically higher followed by tin tomato and then mayonnaise.

- **Acetic Acid:** The concentration of acetic acid analyzed ranged from 0.002 ± 0.005mg/kg to 0.026 ± 0.02mg/kg in Chicken sausage at Ose. The values are within the permissible limits set by WHO/FAO and NAFDAC as shown in table 4.4 above. The ANOVA results shows that the F-calculated is larger than the F-critical and P-value (0.0001) is far below the standard significance value of 0.05, we reject the null hypothesis because there is a significance difference between the acetic acid preservative in all the canned foods purchased at Ose. Turkey HSD Post Hoc analysis showed that acetic acid in chicken sausage is statistically higher followed by tin tomato, mayonnaise, sweet corn and corn beef.

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Samples	Benzoic acid Mg/kg	Propyl gallate Mg/kg	Citric acid Mg/kg	Sorbic acidMg/kg
A	5630 ± 2500	2500 ± 530	ND	ND
B	31470 ± 230	21530 ± 350	ND	104200 ± 700
C	11200 ± 200	ND	ND	15200 ± 200
D	24600 ± 1130	ND	12900 ± 560	ND
E	63330 ± 670	ND	1480 ± 60	7630 ± 50
WHO/FAO	1000	200	300	2000
NAFDAC	1000	200	300	2000

Table 3: Preservative levels of Canned Foods at Ochanja

ND: Not Detected

The results in table 3 above shows the concentration of preservatives in the analysis of canned foods purchased from different vendors at Ochanja Market Onitsha.

- **Benzoic Acid:** The concentration of benzoic acid in mayonnaise from Ochanja ranged from 5630 ± 2500mg/kg to 63330 ± 670mg/kg. These values exceeded the permissible limits set by WHO/FAO and NAFDAC as shown in the table 3 above. This agrees with the work done by Akolawole *et al*.2022 and Onwordi *et al*.2017 [19]. The ANOVA result shows that F-value is greater than F-critical, and the P-value (2.70×10^{-4}) is much lower than the standard (0.05), we reject null hypothesis because there is statistically significant difference between the benzoic acid in canned foods purchased at Ochanja. Turkey HSD Post Hoc analysis shows that benzoic acid in mayonnaise was significantly higher followed by chicken sausage, sweet corn, corn beef and then tin tomato.

- **Propyl Gallate:** The concentration of propyl gallate in chicken sausage from Ochanja ranged from 2500 ± 530mg/kg to 21530 ± 350mg/kg. There was no detectable propyl gallate in corn beef, sweet corn and mayonnaise, these values exceeded the permissible limits set by WHO//FAO and NAFDAC as shown in the table 3 above. The ANOVA result shows that F-value is greater than F-critical and the P-value is 0.0001 smaller than the standard (0.05), we reject the null hypothesis because there is a statistically significant difference between the propyl gallate preservative in canned foods purchased at Ochanja. Turkey HSD Post Hoc analysis shows propyl gallate in chicken sausage was significantly higher followed by tin tomato [20].

- **Citric Acid:** The concentration of citric acid in sweet corn from Ochanja ranged from 1480 ± 60mg/kg to 12900 ± 560mg/kg. There was no detectable citric acid in tin tomato, chicken sausage and corn beef. These values are above the permissible limit set by WHO/FAO and NAFDAC as shown in table 3 above but a good manufacturing practice is required. The ANOVA result shows that at 95% confidence the calculated F-value is larger than the critical value and the P-value (8.66×10^{-5}) is much lower than the standard (0.05), we reject the null hypothesis because there is statistically significant difference between the citric acid preservatives identified at Ochanja. Two sample independent t-test shows that citric acid in sweet corn was significantly higher followed by tin tomato.

- **Sorbic Acid:** The concentrations of sorbic acid in chicken sausage from Ochanja ranged from 7630 ± 50mg/kg to 104200 ± 700mg/kg as shown in Table 3 above. There was no detectable sorbic acid in tin tomato and sweet corn. These values are above the permissible limit set by WHO/FAO and NAFDAC. This agrees with the analysis done by (Onwordi *et al*., 2017) the citric acid values of about 21% of the samples analyzed had value above required limit. The ANOVA result shows that F-value is greater than F-critical and the value of P 0.0001 is smaller than the standard (0.05), we reject the null hypothesis because there is a statistically significant difference between the sorbic acid preservative in canned foods purchased at Ochanja. Turkey HSD Post Hoc analysis shows that the concentration of sorbic acid is significantly higher in chicken sausage, followed by corn beef and mayonnaise.

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3.1. Health Risk Assessment

Sample	Calcium propionate (HQ)	Sodium benzoate (HQ)	Potassium sorbate (HQ)	Propionic acid (HQ)	Acetic acid (HQ)	Risk status
A	6.14×10^{-6}	2.46×10^{-5}	8.29×10^{-7}	9.14×10^{-6}	1.86×10^{-6}	Safe (HQ < 1)
B	2.36×10^{-5}	1.13×10^{-4}	6.00×10^{-6}	0.00	1.86×10^{-6}	Safe (HQ < 1)
C	9.14×10^{-6}	1.66×10^{-4}	1.00×10^{-6}	4.31×10^{-5}	1.43×10^{-7}	Safe (HQ < 1)
D	1.70×10^{-6}	1.14×10^{-4}	7.17×10^{-6}	0.00	2.14×10^{-7}	Safe (HQ < 1)
E	4.46×10^{-5}	3.99×10^{-4}	0.00	8.50×10^{-6}	9.29×10^{-7}	Safe (HQ < 1)

Table: 4: Hazard Quotient for Adult for Ose Samples

This is a table showing Hazard Quotient(HQ) for adult at 70kg purchased at Ose Market.

Sample	Calcium propionate (HQ)	Sodium benzoate (HQ)	Potassium sorbate (HQ)	Propionic acid (HQ)	Acetic acid (HQ)	Risk status
A	1.433×10^{-5}	5.750×10^{-5}	1.933×10^{-6}	2.133×10^{-5}	4.333×10^{-6}	Safe(HQ < 1)
B	5.500×10^{-5}	2.642×10^{-4}	1.400×10^{-5}	0.000	4.333×10^{-6}	Safe(HQ < 1)
C	2.133×10^{-5}	3.883×10^{-4}	2.333×10^{-6}	1.005×10^{-4}	3.333×10^{-7}	Safe(HQ < 1)
D	4.167×10^{-6}	2.654×10^{-4}	1.673×10^{-5}	0.000	5.000×10^{-7}	Safe(HQ < 1)
E	1.042×10^{-4}	9.304×10^{-4}	0.000	1.983×10^{-5}	2.167×10^{-6}	Safe(HQ < 1)

Table 5: Hazard Quotient for Child

This a table showing Hazard Quotient(HQ) for a child of 15kg

All calculated Hazard Quotient(HQ) as seen in Table 4 and 5 above for both adult and children are significantly less than than 1.0, indicating that consumption of these canned food samples at standarrd daily intake rates poses no non-carcinogenic health hazard.

Sample	HI		Risk status
A	Adult	3.26×10^{-5}	Safe
	Child	9.9×10^{-5}	
B	Adult	1.44×10^{-4}	Safe
	Child	3.3×10^{-4}	
C	Adult	2.19×10^{-4}	Safe
	Child	5.1×10^{-4}	
D	Adult	1.23×10^{-4}	Safe
	Child	2.9×10^{-4}	
E	Adult	4.53×10^{-4}	Safe
	child	1.0×10^{-3}	

Table 6: Hazard Index for Ose samples

This a table showing Total Hazard Quotient(HI) for both adults and child.

For both adults and children, the Hazard index across all samples as seen in Table 6 remain less than 1.0, confirming that exposure to combined mixture of preservatives in these samples presents no significant non-carcinogenic health risk.

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Samples	Benzoic acid (HQ)	Propyl gallate (HQ)	Sorbic acid (HQ)
A	0.804	3.571	ND
B	4.496	30.757	2.977
C	1.600	ND	0.434
D	3.514	ND	ND
E	9.047	ND	0.218

Table 7: Hazard Quotient for adult for Ochanja Samples

ND: Not Detected

This table shows Hazard Quotient(HQ) for a 70kg adult purchased at Ochanja Market.

Citric acid is omitted from HQ tables because it is classified under Good Manufacturing Practice(GMP). It can be used as much as needed to get desired effect, posing negligible toxicological concern at normal dietary levels.

HQ< 1 indicates absence of potential health risk while HQ > 1, this indicates the potential health risk associated with preservatives. From Table 7 above Benzoic acid from sample A(0.804) and Sorbic acid from from sample E(0.218) shows no potential health risk while others indicated high potential health risk except on samples C,D,E where propyl gallate were not detected and sample D and A where sorbic acid was not detected.

Samples	Benzoic acid (HQ)	Propyl gallate (HQ)	Sorbic acid (HQ)
A	1.877	8.333	ND
B	10.490	71.767	6.947
C	3.73	ND	1.013
D	8.200	ND	ND
E	21.110	ND	0.509

Table 8: Hazard Quotient for Child

ND: Not Detected

This table shows Hazard Quotient(HQ) for a 15kg child . HQ < 1 indicates absence of potential health risk while HQ > 1, this indicates the potential health risk associated with preservatives.

From Table 8 above Sorbic acid from sample E only show no potential health risk while others shows potential health risk except on samples C,D,E where propyl gallate were not detected and sample D and A where sorbic acid was not detected.

Sample	HI		Risk status
A	Adult	4.375	No Safe
	Child	10.21	
B	Adult	38.23	No Safe
	Child	89.20	
C	Adult	2.024	No Safe
	Child	4.743	
D	Adult	3.514	No Safe
	Child	8.200	
E	Adult	9.265	No Safe
	child	21.619	

Table 9: Hazard Index for Ochanja Samples

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For both adults and children, the Hazard Index as seen in Table 13 across all samples remains far less than 1.0, confirming that exposure to the combined mixture of preservatives presents significant health risk. The hazard risk for children are consistently 2.33 times higher than those for adults across all samples. This pronounced difference is attributed to thr body weight disparity.

4. Conclusion

The combined application of High-Performance Liquid Chromatography (HPLC) and Gas Chromatography-Mass Spectrometry (GC-MS) demonstrated a robust, sensitive and complementary analytical approach for the simultaneous determination of organic and volatile preservative compounds in complex canned food matrices. The use of triplicate analysis across the five commercially available food brands, together with comprehensive method validation, ensured the accuracy, precision and reliability of the analytical results.

Statistical evaluation using two-way Analysis of Variance (ANOVA) revealed significant variations in preservative distribution among the food brands, confirming that preservative occurence is highly matrix-dependent rather than uniformly distributed. These findings suggest that manufacturers formulate preservative combinations based on the physicochemical characteristics and preservation requirements of individual food products.

The HPLC analysis of five food brands showed that all detected preservatives were within the maximum permissible limits established by regulatory authorities. In contrast, the GC-MS analysis revealed that the concentrations of all detected preservatives exceeded the recommended permissible limits, indicating the need for continuous monitoring and stricter regulatory compliance.

Dietary exposure assessment was performed by estimating the Estimated Daily Intake (EDI) of the detected preservatives and comparing these values with their respective Acceptable Daily Intake (ADI) to determine the Hazard Quotient(HQ) and Hazard Index(HI). For the food brand at Ose, HQ and HI values were less than unity, indicating that exposure to the detected preservatives is unlikely to pose significant non-carcinogenic health risks to consumers in both adults and children. However, for the second food brands at Ochanja, HQ and HI values exceeded unity, suggesting a potential non-carcinogenic health risk associated with long-term consumption of the detected preservatives in both adults and children.

Recommendations

Regulatory agencies should conduct unannounced and routine chromatographic testing of canned foods. Strict penalties should be imposed on brands that exceed the maximum permissible limits. They should mandate disclosure of exact concentration or clear warning labels on products with high preservative levels.

Future toxicological studies should concentrate more on quantitative baseline by conducting in-vivo metabolic tracking. It will help to investigate whether the high dietary intake of these preservatives exceeds the human liver's maximum capacity for glycerine conjugation.

Future research should monitor these exact food brands over accelerated storage timeline using GC-MS. This will track whether these high organic acid loads degrade into secondary toxic by-products like benzene or sorbate trans-neutralization compounds.

Suggestions

There can be a positive correlation between preservatives. Calcium propionate, propionic acid and sodium benzoate can be used together in a formulation to prevent mold, yeast and bacteria activity. Food manufacturers use this pairing to reduce mass of each preservative. A Hurdle technology can be used where a lower amount of preservative system can be used with mild thermal processing or modified atmosphere packaging (MAP).

Sorbates can degrade over a long period. For food matrices that depends on potassium sorbate, there can be a partial substitution of sorbates with natural antimicrobials such as cultured dextrose, nisin or rosemary extracts. This shift preserves antimicrobial efficacy against yeast and molds minimizing chemical preservatives carrying loads.

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