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An Evaluation of the Chemical Composition of Soft Drinks in Nigeria: A Principal Component Analysis Approach

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ABSTRACT

This study aims to determine the relationship between the chemical compositions of twenty-five (25) soft drinks sold in Nigeria. Sample concentration of twenty-five (25) soft drinks used in the study was collected from the National Agency for Food and Drug Administration and Control (NAFDAC). Principal Component Analysis (PCA) was employed to explain the relationship between the chemical compositions and determine the soft drinks' chemical composition distribution. The result has shown that all except acidity and antioxidant has a significantly strong positive relationship among the chemical structures. PCA suggested retaining three components that explained about 82.465 per cent of the data set's total variability. It was observed that carbonated water, fructose, sucrose, main concentration, stabiliser, E412, colouring and gelatin were the major compositions of the soft drinks in Nigeria, Base on the findings in this study, it is recommendations that; Consumers who are allergic to sugar or diabetic should avoid taking any of the soft drinks with high sugar concentration. Soft drinks companies producing drinks with high sugar content should consider their customers who are diabetic and allergic to high sugar levels.

1. INTRODUCTION

Soft drinks' is used to define beverages with remarkable alcoholic or hot beverages, this includes an enormous array of products ranging in arrangement from mineral waters, sports drinks, diet formulations, colas, mixers, and tonics to fruit juices, and few soft drinks are sparkling (carbonated), whereas others are still. Some are produced with a designated shelf-life higher than a year, whereas others are sold for immediate consumption (freshly squeezed juices) [1]. As a result of this change in composition and endorsement, soft drinks' microbiology also shows appreciable changes. Some soft drinks form an aggressive environment, or so deficient in nutrients that the microflora is nearly nonexistent, and spoilage is rare. New soft drinks, such as fruit juices of a higher pH form an environment ideal for the rapid proliferation of yeasts, moulds, and bacteria, were produced in large quantities [2].

Soft drinks may make a valuable addition to fluid intake and have become, to some extent, determined as part of the daily diet, particularly of young children and adolescents. The nutritional value of some readily available soft drinks include; Squashes, crushes, cordials, and carbonated beverages are, however, of little nutritional value (apart from their energy content) as their main ingredients are water and sugar. These soft drinks can be a useful vitamin C source, although they are unlikely to contain a substantial amount unless the vitamin is included. Soft drinks do not contain fat or fibre but may contain nutritionally insignificant protein traces [3].

The energy theme of soft drinks varies greatly and is derived wholly from the sweetening agents, principally sugars. Soft drinks sweetened with a combination of sugar and intense sweeteners are less caloric than drinks sweetened entirely with sugar, and beverages labelled as low-calorie are required by United Kingdom law to contribute a maximum of 22 kJ (5 kcal) per 100 ml. [4]. The added sugar theme of soft drinks ranges from 6 to 10% and is usually made up of glucose and fructose, with small sucrose and perhaps maltose. The sugar theme of soft beverages is regulated by the United Kingdom 1964 Soft Drinks Regulations (amended 1969, 1970, and 1976). The beneficial assessment of a soft drink as taken depends on the watering factor, which must now be stated on the label of all dilutable drinks. Soft drinks are a significant market for energy sweeteners, mostly in the United Kingdom. Unlike other countries, they can be used together with nutritive sweeteners and are therefore restricted to dietetic beverages. There are scientific reasons and objectives for considering the need for intense sweeteners in soft drinks. Not one sweetener is grandly suited to meet all the soft drinks conditions, and another's vigour can offset one sweetener's weakness. The enhancement of soft drinks with artificial sweeteners reduces the energy content and encourages fluid consumption without decreasing the diet's nutrient density. The more progressive use of artificial sweeteners, the more the acceptability of daily intake levels, and the increased number of sweeteners available have resulted in a wide range of low-calorie beverages sufficient to many buyers. Customers have been directed to ensure that they take a blend of sweeteners to avoid vast intakes of any one type [5]. Soft drinks are widely consumed in Nigeria, and it is generally believed that they contain large amounts of sugars, calories and many other ingredients. However, there is no local study to define these drinks' composition and classify them using statistical tools. This information is essential in giving dietary advice, especially to those on special diets. Soft drinks exist in various compositions and brands and are marketed by different brewery industries [6, 7]. These drinks are readily devoured daily, especially when undergoing worrisome activities like hard work and sport [8]. With the relatively economical prices, they are highly consumed during leisure and relaxation outings and serve the general public on occasions such as traditional marriages, weddings, funerals, etc. [9]. The tremendous volume consumption rate of soft drink is attributed to the characteristic taste and flavour and their thirst extinction potential [10]. These attributes are defined by the Constituents present such as sugar responsible for its sweetness, carbonated water that is water compressed with carbon dioxide makes it the best thirst quencher and flavouring agents to add flavour to the drinks [11]. In addition to taste pleasure, soft drinks contain other ingredients such as vitamins, phosphates, acids, antioxidants, etc., which are nutritional and health benefits to the body [12, 13].

Carbonated drink in the Nigerian market has been controlled since the 1950s by big international beverage drink company. Their brands have been a delight for the end-user of all ages. In 1953 Coca-Cola was introduced in Nigeria, while in 1960, 7ups was first introduced. PepsiCo later managed 7up from 1990. The exemplary Coca-Cola brands and the ever tenacious PepsiCo brands have controlled the Nigerian carbonated soft drink market for so long a time. Even when other brands try to maintain their unique selling ability to the consumers, the Cola-Cola and PepsiCo brands have always stormed different competition weather from year to year. Down the memory line from the '80s came Dr Pepper, Afri-Cola, Canada Dry, Limca, Tandi, Brahma e.t.c. They all came and were dominated by the two biggest brands. It had been a two straight rivalry, contenting in vigour-to-vigour, and weakness-to-weakness. Coke vs Pepsi, 7-Up vs Sprite, Fanta vs Mirinda and Schweppes vs Teem competed for dominant. Soft drinks were packed in returnable and reusable glass bottles, until the year 2001, immediately the La'Casera brands introduced its Apple brand, it grew in popularity.

La'casera brand was the first to spread carbonated PET jug drink in Nigeria. The shoppers found another adoration in Pet jug, and the two warriors followed suits in dispatching theirs in 2004. The warmth of the opposition was turned on purchasers selling techniques and different pressing medium and sizes: glass bottle (33 cl), (50cl) and pet jug (50 cl) and aluminium jars 33 cl. The customer experience was uplifted, and the shoppers' decision got limitless. For over ten years, different market measurements demonstrated the La'casera brands gave a decent rivalry to Coca Cola and Pepsico, with La'Casera pet jug's presentation. However, for a few years now the La'Casera brands have been slackening its steam because of buyers developing complex culture, taste and some inside emergency in the La'casera Company. This license the age-long strength of the two combatants in the Nigeria carbonated soda pop market. At that point from a safe house came the Aje brand of Big. The Big Cola, Big Orange. Their selling point is the presentation of 65 cl pet container which gave buyers' perpetual freedom of decision. A new market study showed that Aje large brand appreciates critical support even inside its brief timeframe of market dispatch. Although PepsiCo reacted with 60 cl jug presentation, Aje novel "large' of 65cl is making shoppers' compassion and new customer experience. Over a couple of months, the early market participants returned to their unique 50ml pet sizes, while Aje Big proceeded with its exceptional 65 ml. In these, the purchaser is the champ. The crises of new brands made annihilation in the buyers' market, with the introduction of Aje Big, King Soda, Frizz, and Rite's Bigi mark generally in the PET jug section. Ritual's Bigi carbonated sodas' appearance is valued by numerous purchasers, pressed in 60ml PET jug. Rituals are the proprietors of Bigi brands, a grounded wheat flour-based, meat-filled prepared hotdog move snacks pulverised the wiener move market six years back. The Rite Group recently dispatched Rite's Bigi sodas into Nigeria [14].

An analysis aimed at establishing whether the concentrations of harmful metals in soft drinks usually taken are the lower or upper limit for all the metals set by the World Health Organization (WHO). Twenty (20) brands of soft drinks commonly consumed in Lagos, Nigeria, for the presence of lead, cadmium, nickel, silver, chromium and zinc applying standard biochemical procedures were examined. Results indicated that cadmium was present in four samples at a concentration ranging from 0.023 to 0.158 mg/L. The lead was discovered in three of the samples at an absorption level from 0.5045 to 3.0275 mg/L, and nickel was seen in six of the samples at an absorbing level from 0.016 to 0.063 mg/L while silver was not seen in all of the samples [15]. Constituents of twenty-five (25) soft drinks in Nigeria was evaluated and reviewed for the presence of some heavy metal. The soft drinks were tested for sugar, carbon dioxide, phosphate, alcohol, PH and acidity resolved. The amount of cadmium, mercury and lead were established using atomic absorption spectrophotometer. The result revealed sugar, carbon dioxide, phosphate, and alcohol in soft drinks. Activity, PH ranging from 3 to 5 with an average of 3.6 and the acid concentration was small between 3 and 12g/L with 8.1g/L presents in the soft drinks [8]. Aloh et al. [16] determined the type and quantity of sugar present in each of the two soft drinks. Knight and Alien EDTA methods determined the type of sugar present; the result showed that all the brands of soft drinks tested contained sucrose as the only sugar present. The sugar level and the densities varied through the brands in the order. Pepsi>Coke>Gold Sport>Limca>Sprite>7up>Fanta>Miranda. The mean sugar concentration for all the soft drinks in Ebonyi State was 32.4856mg. Though there were differences between the sugar values, it still falls within an acceptable limit. The soft drinks were all acidic at room temperature. The quantity of sugar in carbonated water and fruit juices was obtained by density and refractometric methods. Also, the number of different sugars were determined using infrared spectroscopy coupled with PLS analysis. The result indicated that sucrose is critical in sugar-added organic product juices (FJ1–FJ6), and there is no sucrose in non-sugar-added juices (FJ7–FJ10). Besides, the measure of fructose is higher in sodas contrasted with sugar added juices [17]. Sodamade [18] examined ten (10) samples of soft drinks available in Nigerian markets and analysed total soluble sugars using the spectrophotometric technique. The result showed that the soft drinks' sugar contents range between 9.91+0.0141 g/100ml in A1 to 13.55 +0.0071g/100ml in A3. These selected samples' sugar contents were within the specified standard of Nigeria's standard organisation of 7.00 – 14.00 g/100ml. Martin-Villa et al. [19] analysed the qualitative and quantitative composition of soluble carbohydrates consumed in sixteen (16) soft drinks. The conditional analysis was carried out by thin-layer chromatography while the quantitative resolution was performed by column chromatography and spectrophotometric method. Most of the soft drinks analysed contain the monosaccharides glucose, fructose and disaccharide sucrose while the quantity of these sugars differs from bottle to bottle. The content of total soluble carbohydrates of most of the drinks analysed is rather high. It may represent an important caloric supplement in the diet, considering the high consumption of these drinks by the Spanish population. Idris et al. [20] determine the amount of sugar and PH in financially available soft drinks in Jazan, Saudi Arabia. It further compared their labelled quality to inform the regulations. The result indicated that calculated sugar in energy drinks (14.3 ± 0.48 and 15.6 ± 2.3, respectively) was larger than the carbonated drinks (11.2 ± 0.46 and 12.8 ± 0.99), which was significant statistically. The result also indicated that; there was a significant difference between the consolidation of glucose in energy drinks (5.7 ± 1.7) and the carbonated (4.1 ± 1.4). The PH of these drinks limits from 2.4 to 3.2. There existed a statistically significant difference in the estimated and labelled sugar in carbonated drinks. Orav and Kann [21] studied the numeric and non-numeric difference between volatile aroma compounds in different foods and beverages comprising peppermint and orange aroma using the simultaneous distillation and extraction micro techniques for isolating the fraction capillary gas chromatography for analysing the extracts. There are 41 ingredients in aroma and in the orange aroma of which, twenty-two (22) compounds were identified, the yields of aroma fractions from different materials changes from 0.2 up to 24 mg/g (peppermint) and from 0.03 up to 2 mg/g (orange). Onyemelukwe et al. [22] study sugar and caloric contents of soft drinks marketed in Nigeria. Six (6) different brands of soft drinks marketed all over Nigeria were analysed for their sugar (glucose, fructose and sucrose) and caloric contents. It was discovered that the sugar content ranges between 3.29 to 7.70 grams per bottle with a caloric value ranging between 13.2 and 30.8 kilocalories per bottle. Imamura et al. [23] studied the possible relationship between demand for sugar-sweetened beverages, artificially sweetened beverages, and fruit juice with type 2 diabetes before and after adiposity adjustment was examined. Survey analysis and random-effects meta-analysis and for population peculiarity associated with the consumption of sugar-sweetened beverages. Pre-specified information was extracted from 17 cohorts (38253 cases/10126754 person-years). The result shows that higher consumption of sugar-sweetened beverages was associated with a greater incidence of type 2 diabetes.

The literature reviewed has not discussed the significant chemical structures present in the soft drinks sold and consumed in Nigeria. It has not also shown the distribution of chemical compositions in the soft drinks based on their components. Therefore, this research is set out to study the significant chemical compositions present in the twenty – five (25) soft drinks and the distribution of chemical compositions based on the Principal components. It will also try to fill the identified gaps in the literature with updated data and methodology.

This study's main purpose is to define the clusters of soft drinks in Nigeria explicitly, to determine the relationship between the chemical compositions of the twenty-five (25) soft drinks, ascertain the components to be retained and distribute the chemical composition into specific components. The materials and methods are described in Section 2 of the study. Section 3 presents data analysis and interpretation, and finally, conclusions and recommendations are presented in section 4.

2. MATERIALS AND METHODS

2.1 Source of data

Sample concentration of twenty-five (25) soft drinks was used in this study, and the sample concentration was collected from the National Agency for Food and Drug Administration and Control [24].

2.2 Principal component analysis

Principal Component Analysis is a multivariate methodology used for changing a set of correlated variables into a set of uncorrelated variables that explains the decreasing proportions of the change in the original observations [25]. Suppose the first few derived variables (the principal components) account for a large proportion of the observed variables' total variance. In that case, they can provide a convenient summary of the data and simplify subsequent analysis. Algebraically, the principal component is the linear combinations of the p random variables $X_1, X_2, \dots, X_p$. Geometrically, these linear combination is the picking of a new coordinate order obtained by rotating the original system with $X_1, X_2, \dots, X_p$ as the coordinate axes. The new axes represent the directions with maximum variability and provide a simpler and more parsimonious description of the covariance structure [26]. Principal components rest entirely on the covariance matrix $\boldsymbol{\Sigma}$ (or the correlation matrix ρ) of $X_1, X_2, \dots, X_p$.

Suppose X is a vector of p random variables, the function of the principal component analysis transformation is to search for a few $(< p)$ derived variables that save most of the information given by the variance of the p random variable [27]. Let the random vector $X' = [X_1, X_2, \dots, X_p]$ have the covariance matrix Σ with eigenvalues $\lambda_1 \geq \lambda_2 \geq \dots \geq \lambda_p \geq 0$.

Consider the linear combinations;

$$Y_j = \alpha_j' X = \alpha_{j1}' X_1 + \alpha_{j1}' X_1 + \dots + \alpha_{jp}' X_p = \sum_{i=1}^{p} \alpha_{jk} X_k, \ j = 1,2,\dots,p \text{, of the element of } X \quad (1)$$

where, α_j is a vector of p components $\alpha_{j1}, \alpha_{j2}, \dots, \alpha_{jp}$.

Then,

$$Var\,(Y_j) = \alpha_j' \sum \alpha_j \qquad j = 1,2,\dots,p \quad (2)$$

$$Cov\,(Y_j, Y_k) = \alpha_j' \sum \alpha_k \qquad j,k = 1,2,\dots,p \quad (3)$$

The PCs are those unrelated linear combinations $Y_1, Y_2, \dots, Y_p$ whose variances in (2) are as large as possible [28]. In finding the principal components, the variance is considered. The first stage is to look for a linear combination $\alpha_1' X$ with maximum variance, so that;

$$\alpha_1' X = \alpha_{11} X_1 + \alpha_{12} X_2 + \dots + \alpha_{1p} X_p = \sum_{i=1}^{p} \alpha_{1k} X_k \quad (4)$$

The linear combination $\alpha_2' X$ uncorrelated with $\alpha_1' X$ have a maximum variance and at the k^{th} stage a linear combination

$\alpha'_k X$ is discovered to have a maximum variance subject to being uncorrelated with $\alpha'_1 X, \alpha'_2 X, \dots, \alpha'_{K-1} X$. The k^{th} derived variable$\alpha'_k X$ is the k^{th} principal components [29]. Up to $p^{th,}$ principal components could be found, but we have to stop after the q^{th} stage ($q \leq p$) when most of the X changes have been accounted for by q principal components.

The variance of principal components is equal to the eigenvalue corresponding to that principal components;

$$Var(Y_j) = \alpha'_j \sum \alpha_j = \lambda_j \qquad j = 1,2,\dots,p \tag{5}$$

The total variance in observation is equal to the total variance of the principal components

$$\begin{aligned}\sigma_{11} + \sigma_{22} + \dots + \sigma_{pp} &= \sum_{j=1}^{p} Var(X_j) \\ &= \lambda_1 + \lambda_2 + \dots + \lambda_p \\ &= \sum_{j=1}^{p} Var(Y_j)\end{aligned} \tag{6}$$

The data is standardised for the variables to have the same scale using a common standardisation method of transforming observations to have zero mean and unit standard deviation [30]. For a random vector $X' = [X_1, X_2, \dots, X_p]$ the corresponding standardised variables are;

$$Z = \left[Z_j = \frac{(X_j - \mu_j)}{\sqrt{\sigma_{jj}}}\right] \; j = 1,2,\dots,p \tag{7}$$

In matrix notation,

$$Z = \left(V^{1/2}\right)^{-1} (X - \mu) \tag{8}$$

where, $V^{1/2}$ Is the diagonal standard deviation matrix. Thus and $E(Z) = 0$ and $COV(Z) = \rho$.

The principal components of Z can be obtained from the eigenvectors of the correlation matrix ρ of X. The previous properties for X are applied to the Z so that the notation Y_j refers to the j^{th} principal components and (λ_j, α_j) Refers to the eigenvalue-eigenvector pair. However, the quantities derived from Σ are different from those derived from ρ [28]. The j^{th} PC of the standardised variables $Z' = [Z_1, Z_2, \dots, Z_P]$ with $Cov(Z) = \rho$ is given by;

$$Y_j = \alpha'_j Z = \alpha'_j \left(V^{1/2}\right)^{-1} (X - \mu) \tag{9}$$

So that

$$\sum_{j=1}^{p} Var(Y_j) = \sum_{j=1}^{p} Var(Z_j) = P \quad j = 1,2,\dots,p \tag{10}$$

Therefore, $(\lambda_1, \alpha_1), (\lambda_2, \alpha_2), \dots, (\lambda_p, \alpha_p)$ are the eigenvalue-eigenvector pairs for ρ with $\lambda_1 \geq \lambda_2 \geq \dots \geq \lambda_p \geq 0$.

2.3 Interpretation of principal components results

The loading or the eigenvector $\alpha_j = \alpha_1, \alpha_2, \dots, \alpha_p$, can be characterised as the proportion of the importance of a variable in a given principal component. When all elements of $\alpha_{1,}$; are positive, the main segment is a weighted normal of the factors, and it can be referred to as a measure of overall soft drink composition. Similarly, the positive and negative coefficients in propose components can be regarded as the different chemical composition [25, 29, 31]. The next procedure finds a second linear combination, uncorrelated with the first component, such that it accounts for the next largest amount of variance (after the variance attributable to the first component has been removed) in the system [32].

The new principal component observations Y_{ij} are gotten basically by subbing the first factor X_{ij}into the set of the first q PCs.

$$Y_{ij} = \alpha'_{j1} X_{i1} + \alpha'_{j2} X_{i2} + \dots + \alpha'_{jp} X_{ip}, i = 1,2,\dots,n, \quad j = 1,2,\dots,p \tag{11}$$

The plot of the second or third PCs against each other enhances visual interpretation [33].

2.4 The proportion of variance

The proportion of variance describes the principal components that best explained the original variables. It is a degree of how well the first q principal components of Z explain the variation is given by;

$$\psi_q = \frac{\sum_{j=1}^{q} \lambda_j}{p} = \frac{\sum_{j=1}^{q} Var(Z)}{p} \tag{12}$$

cumulative proportion of explained variance is an important criterion for determining the number of components to be preserved in the analysis. A Scree plot gives an outstanding graphical presentation of the principal components' potency to explain the variation in an observation [34].

3. DATA ANALYSIS AND INTERPRETATION

The first result from the analysis in Table 1 is the descriptive statistics for all the composition of the soft drinks, from the result, sucrose is the essential chemical composition of soft drinks because it has the highest mean of 3.7564.

Table 2 presents the correlation matrix of the chemical compositions of the twenty-five (25) drinks. The result shows that; carbonated water has a significantly strong positive association with fructose, sucrose, main concentrations, stabilisers, E412 and colouring, and a weak positive correlation with gelatin. Fructose has a significantly strong positive relationship with sucrose, main concentrations, stabilisers, E412, colouring and gelatin. There existed a strong positive association between main concentrations, stabilisers, E412 and colouring. Main concentration has a significantly strong positive correlation between and stabilisers, E412, colouring and gelatin. The preservative has a significant relationship with antioxidant, and the stabiliser has a significant relationship with E412, colouring and gelatin, E412 has a significant relationship with colour. Gelatin has a significant positive relationship with colouring. In contrast, acidity and antioxidant have no significant relationships with other chemical composition. All except acidity and antioxidant have a significantly strong positive relationship which implies that all these chemical compositions are significantly and positively related; hence, a rise in one may lead to an increase in another.

In the result presented in Table 3, the null hypothesis which states that the Correlation matrix is an identity matrix was rejected at 5% level of significance (Bartlett's test of Sphericity; $\chi 2 = 350.897$, p-value = 0.000), this implies that the correlation in the observation is appropriate for factor analysis. Also, "Kaiser-Meyer-Olkin statistic = .748" revealed that adequate sampling is being used for this analysis.

Communities of the chemical ingredients of the 25 soft drinks are present in Table 4, and this is the ratio of each variable's variance explained by the chemical compositions. The result indicated that over 90% of the variance in carbonated water, fructose, stabiliser and E412 was accounted for in each drink. The result also showed that over 80% of the main concentration variance, preservative, antioxidant, colouring, and gelatin is accounted for. In contrast, over 70% of the glucose and sucrose was accounted for. All chemical compositions of the twenty-five (25) soft drinks except acidity has explained variance higher than 0.5 (minimum value), this led to the removal of acidity from the analysis.

The result of the eigenvalues and the cumulative proportions of the explained variance are displayed in Table 5. Considering the eigenvalue criterion and the Scree plot in Figure 1, it would be reasonable to retain the first three principal components. The decision rule says that it is sufficient to keep only principal components with eigenvalues larger than 1. The first three principal components can be retained to explain 82.465 per cent of the total variability.

Table 6 and Figure 2 present the concentrations and loading of soft drinks' chemical components in the three principal components that explain 82.465 per cent of the total variability in the retained data set.

Component one (1): Fanta, seven-up, coke, light coke, diet coke, teem, sprite, Mirinda has a strong positive relationship with carbonated water, fructose, sucrose, main concentration, stabiliser, E412, colouring and gelatin as the primary chemical compositions of the soft drinks in these components and an inverse relationship with; glucose, preservative and antioxidant.

Component two (2): Schweppes, limca, Afri-cola, Pepsi, Maltina, Maltonic, Amstel, malt, hi malt; identified glucose, preservative and antioxidant as the significant soft drink chemical compositions.

Component three (3): 5-live, chivita, vital milk, mountain dew, krest, soda water, Fanta tonic, Fanta Lemon, Fanta pineapple; identified colouring and gelatin as the chemical composition in the soft drinks under this component.

Table 1. Descriptive analysis

Composition	N	Minimum	Maximum	Mean	Std. Dev.	Skewness		Kurtosis	
carbon.water	25	1.05	3.95	1.5861	.79342	2.058	.464	3.702	.902
Glucose	25	.26	.76	.4144	.11951	1.173	.464	1.728	.902
Fructose	25	.04	3.51	.7349	1.01445	1.682	.464	2.032	.902
Sucrose	25	.04	13.79	3.7564	4.12300	1.116	.464	.411	.902
Main contr.	25	.00	2.03	.4677	.55991	1.754	.464	2.432	.902
Acidity	25	.00	6.37	.6464	1.26107	4.213	.464	19.347	.902
Preservative	25	.48	18.03	2.1856	3.43302	4.423	.464	20.894	.902
Stabilizer	25	.03	9.10	1.5681	2.26762	1.955	.464	4.082	.902
E412	25	.02	4.94	.8036	1.10654	2.548	.464	7.675	.902
Antioxidant	25	.02	5.58	.7164	1.27335	2.770	.464	8.556	.902
Colouring	25	.07	8.73	1.8064	2.47310	1.894	.464	2.891	.902
Gelatin	25	.02	5.41	1.4804	1.34740	1.179	.464	1.379	.902

Table 2. Correlation matrix

Compositions	Carb.	Glucose	fructose	sucrose	Main	Acidity	Pres.	Stab.	E412	Anti.	Col.	Gel.
Carb.water	1											
Glucose	-0.117	1										
Fructose	.966**	-0.101	1									
Sucrose	.798**	-0.262	.831**	1								
Main	.917**	-0.116	.904**	.744**	1							
Acidity	-0.101	-0.047	-0.125	-0.165	-0.12	1						
Preservative	-0.116	.740**	-0.134	-0.171	-0.13	0.012	1					
Stabilizer	.938**	-0.035	.971**	.813**	.843**	-0.122	-0.081	1				
E412	.923**	-0.031	.938**	.786**	.796**	-0.113	-0.073	.980**	1			
Antioxidant	-0.17	.647**	-0.154	-0.242	-0.19	-0.019	.865**	-0.132	-0.11	1		
Colouring	.607**	-0.106	.675**	.544**	.540**	-0.184	-0.203	.577**	.478*	-0.184	1	
Gelatin	.470*	-0.223	.492*	0.369	.423*	-0.104	-0.343	.397*	0.315	-0.361	.827**	1

** Correlation is significant at the 0.01 level of significance (2-tailed). * Correlation is significant at the 0.05 level of significance

Table 3. KMO and Barlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**0.748**
Bartlett's Test of Sphericity	Approx. Chi-Square	350.897
	Df	66
	Sig.	0.000

Table 4. Communalities

Compositions	Initial	Extraction
Carbonate wat.	1.000	.955
Glucose	1.000	.761
Fructose	1.000	.985
Sucrose	1.000	.769
Main	1.000	.833
Acidity	1.000	.299
Preservative	1.000	.896
Stabilizer	1.000	.958
E412	1.000	.926
Antioxidant	1.000	.841
Colouring	1.000	.856
Gelatine	1.000	.818

Table 5. Eigenvalues

Compositions	Initial Eigenvalues		
	Total	% of variance	Cumulative %
Carbonated water	6.253	52.111	52.111
Glucose	2.498	20.819	72.930
Fructose	1.144	9.535	82.465
Sucrose	.933	7.779	90.244
Main	.410	3.421	93.664
Preservative	.217	1.811	97.626
Stabilizer	.147	1.221	98.848
E412	.085	.712	99.559
Antioxidant	.037	.306	99.865
Colouring	.009	.076	99.942
Gelatin	.007	.058	100.000

Table 6. Eigenvectors

	Component		
	1	**2**	**3**
Carbonated water	**0.956**	0.166	-.119
Glucose	-.231	**0.814**	0.211
Fructose	**0.975**	0.171	-.068
Sucrose	**0.864**	0.036	-.145
Main concentrate	**0.895**	0.133	-.121
Preservative	-.276	0.**903**	0.067
Stabilizer	**0.939**	0.232	-.149
E412	**0.900**	0.250	-.232
Antioxidant	-.315	**0.855**	0.104
Colouring	**0.729**	-.065	**0.566**
Gelatin	**0.602**	-.295	**0.607**

Extraction Method: Principal Component Analysis.
a. three components extracted.

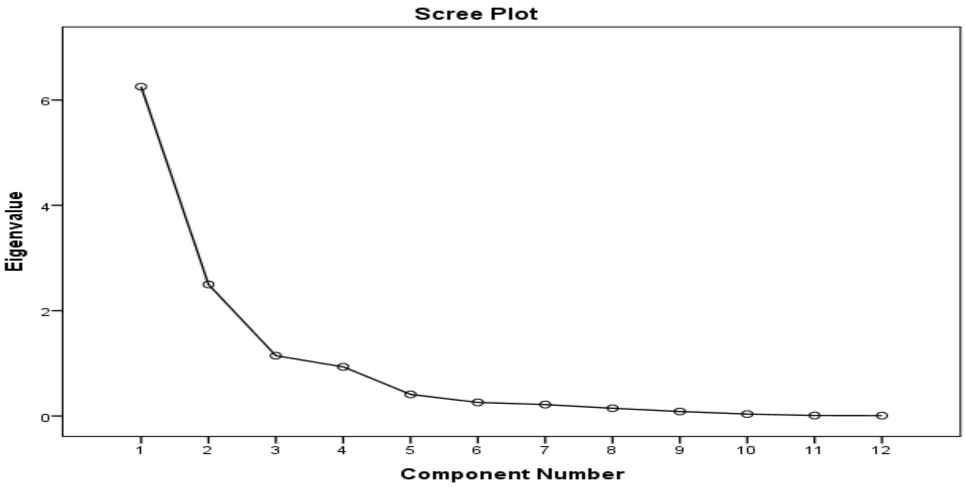

Figure 1. Scree plot

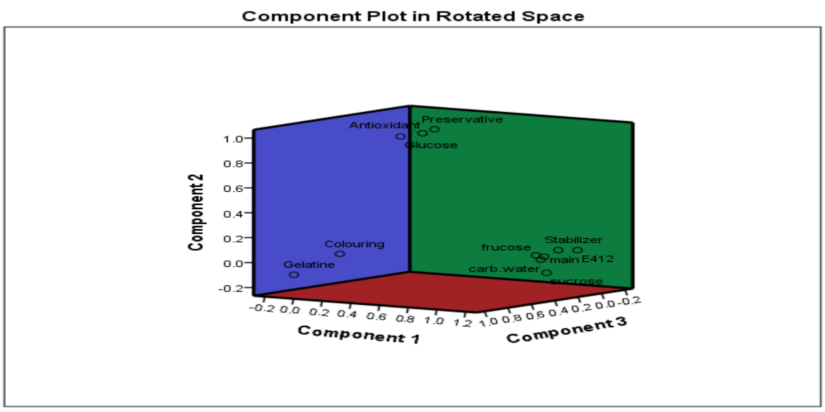

Figure 2. Component plot in rotated space

4. CONCLUSIONS AND RECOMMENDATIONS

Principal Component Analysis (PCA) is an effective means of reducing the dimension of a large set of variables to a small number of factors. In this study, twelve (12) chemical compositions of 25 soft drinks samples sold in Nigeria since the last twenty (20) years was considered. The results showed that all except acidity and antioxidant has a significantly strong positive relationship among the chemical compositions. The proportion of the variable's variance that can be interpreted or explained by the chemical compositions indicated that all chemical composition except acidity is higher than 0.5. Therefore, principal Component Analysis suggested removing acidity from the analysis and retainment of the first three principal components because it explained up to 82.465 per cent of the total variability. It was also observed that carbonated water, fructose, sucrose, main concentration, stabiliser, E412, colouring and gelatin were the significant compositions of soft drinks in Nigeria because they had a strong positive (greater than 0.5) Eigenvectors.

The distribution of the chemical compositions of soft drinks in Nigeria indicated that; carbonated water, fructose, sucrose, main concentration, stabiliser and E412 were the significant compositions of Fanta, seven-up, coke, light coke, diet coke, teem, sprite, Mirinda. Schweppes, limca, Afri-cola, Pepsi, Maltina, Maltonic, Amstel malt, and Hi malt had high antioxidant, preservative, and glucose loading. In contrast, 5-live, chivita, vital milk, mountain dew, krest, soda water, Fanta tonic, Fanta Lemon, Fanta pineapple had high loading in colouring and gelatin as the significant soft drink chemical compositions.

Base on the findings in this study, the following recommendations are suggested. Customers who are allergic to sugar or diabetic should avoid taking any of the soft drinks listed under component one (1) because of a high sugar concentration. For energy requirement, consumers should consider taking drinks with high scores in component two (2). Soft drinks companies producing drinks with high sugar content should consider their customers who are diabetic and allergic to high sugar levels.

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