

The Export Ban of Raw Mineral Commodities of Indonesia: Resource Nationalism or a Means to Growth?

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Abstract: Indonesia's export ban of raw mineral commodities is generally described as resource nationalism. As resource nationalism could bring prosperity to the country and the people, it also, when mismanaged, the could push the country to fall into the resource curse. Therefore, it is important to anticipate which way this export ban would lead Indonesia's economy. Simple parameters that can be used to measure the impact of the export ban are the economic freedom index and the values of GDP. We use the freedom index provided by The Heritage Foundation and GDP values provided by The World Bank and measure the values against the chronological events of implementation and release of regulations related to the export ban. The results indicate that despite how the export ban of Indonesia is often described as a part of resource nationalism, this export ban actually does not bring negative impact to the economy of Indonesia.

Keywords: resource nationalism, export ban, GDP, economic freedom index

1. INTRODUCTION

Resource nationalism is often considered as double-edged sword in term of economic development. In a way it could bring prosperity to the country and the people by maximizing benefit gained through the use of natural resources. In the other hand, when mismanaged, the resource nationalism could push the country to fall into the resource curse. One of the definitions that hit the core of resource nationalism is provided by Li and Adachi in 2017. Resource nationalism is essentially mandatory government intervention in natural resources business by political or economic means in order to benefit the nation and the people it on behalf of (Li & Adachi, 2017).

When the government of Indonesia decided to release the new mining law, there is a subset of the law that could be considered as an event of resource nationalism. Article 103 of the Mining Law of The Republic of Indonesia Number 4 of 2009-Concerning Mineral and Coal Mining states that Production Operation Mining Permit holders and Special Mining Permit holders have to process and refine or smelt mining products domestically (Minister of Law and Human Right of The Republic of Indonesia, 2009). Consequently, this article leads to a trade policy that sets an export ban on the raw mineral commodities. This trade policy is supposedly to take place by at least January 12th 2014. However, it has been five years since that date, and the policy is kept delayed. The delay, directly and indirectly, would bring problems into the economy of Indonesia.

The chronology of the implementation of the export ban goes as following: in 2009, the underlying law for the export ban was released, which was the Mining Law of The Republic of Indonesia Number 4 of 2009-Concerning Mineral and Coal Mining. However, in 2014, another ministerial regulation, this time is Energy and Mineral Resource Ministerial Regulation Number 1 of 2014 was released. This regulation rules that instead of in 2014, the ban of exporting raw mineral commodities would take place in 2017. During 2013 to 2017, the mineral commodities could be exported in raw form in limited amount. In 2017, the Ministry of Energy and Mineral

Resources again released two ministerial regulations, Number 6 and Number 7 of 2017, which loosen up the export ban again. Then, in 2019, the government has stated to fully ban the export in raw form for nickel commodities specifically by January 2020. These rules for the export ban of raw mineral commodities are certainly confusing, especially for the mining companies and investors. In one hand, the government obligates the companies to invest and build their own smelters, in order to ensure that the raw minerals are processed and exported in processed forms. In other hand, the government also permits the companies to still export in raw form as long as the companies are paying the export duty. The ever changing rules of export ban needs to be analyzed to determine whether this export ban will bring the intended benefit as the government wants it to, or it will drive Indonesia to the trap of resource curse.

2. LITERATURE REVIEW

The very basic word definition defines policy as course or principle of action adopted or proposed by a government, party, business, or individual (Oxford, n.d.). Howlett (2014) states that policy design involved the effort to more or less systematically develop efficient and effective policies through the application of knowledge about policy means gained from experience, and reason, to the development and adoption of courses of action that are likely to succeed in attaining their desired goals or aims within specific policy contexts (Howlett, 2014). Basically the export ban is derived from the mining law. In addition to the aim to better optimize the benefit of the mineral commodities, it also indicates the intention of the government of Indonesia to increase control of the mineral resources. Ward (2009) has described a characteristic of resource nationalism as the tendency for states to take (or seek to take) direct and increasing control of economic activity in natural resource sectors (Ward, 2009). This characteristic is further explained by Wilson that established resource nationalism as occurrence where a natural-resource endowed country uses its legal jurisdiction over these resources to achieve some set of national development goals that would otherwise not obtain if their exploitation were left to international market processes. (Wilson, 2009). In the other

hand, resource nationalism also could be explained as development and introduction of new policy by the government that is directed, among others, towards controlling natural monopolies and exerting macro-economic policy influence (Solomon, 2012). Therefore, it can be concluded that the export ban basically is treading upon the resource nationalism. As the resource nationalism has been explicated as double-edged sword, the export ban should be analyzed as to better explain its economic implication.

3. RESULTS

In term of how the new trade policy will affect the economy, first, we check whether this export ban could in fact be classified as a resource nationalism event. Previous research by Li and Adachi (2017) has classified the release of the Mining Law Number 4 as an occurrence of resource nationalism in lower middle and low income countries (Li & Adachi, 2017). This finding then further expanded by analysis of Lowy Institute and United States Geological Survey that shows how Indonesia has become an exemplar of resource nationalism in this decade (United States Geological Survey, 2016), (Warburton, 2017)).

Then, we use the Heritage Index of Freedom. The Heritage Foundation develops Index of Economic Freedom, of which it examines economic policy developments in 186 countries. The index evaluates the rule of law, size of government, regulatory efficiency, and openness of markets (Heritage Organization, 2019). We take the index values of Indonesia for the year of 2000 to 2018, and compare them to the chronological dates of the implementation of the export ban. In Table 1, we mark the occurrence of regulations related to the export ban using 1 when there is a regulation released and 0 when there is no regulation released.

Table 1. Trade freedom index as compared to the occurrence of regulation-related resource nationalism

Year	Indonesia's Index	Export Ban's Chronology
2000	55.2	0
2001	52.5	0
2002	54.8	0
2003	55.8	0
2004	52.1	0
2005	52.9	0
2006	51.9	0
2007	53.2	0
2008	53.2	0
2009	53.4	1
2010	55.5	0
2011	56.0	0
2012	56.4	0
2013	56.9	0
2014	58.5	1
2015	58.1	0
2016	59.4	0
2017	61.9	1
2018	64.2	0

Setting the year of 2009 as the base year, we analyze the impact of the export ban's regulations towards the economic freedom index of Indonesia.

Table 2. Change in economic freedom index compared to the base year of 2009

Year	Comparison to the Base Year
2000	1.03
2001	0.98
2002	1.03
2003	1.04
2004	0.98
2005	0.99
2006	0.97
2007	1.00
2008	1.00
2009	1.00
2010	1.04
2011	1.05
2012	1.06
2013	1.07
2014	1.10
2015	1.09
2016	1.11
2017	1.16
2018	1.20

The increasing nature of the economic freedom index indicates that generally the releases of the regulations that relate to the export ban do not really affected the perceived freedom of economic of Indonesia. Throughout the time, the economic freedom is getting even higher score, indicating higher degree of freedom.

Further, we take the GDP of Indonesia into account. We use the Indonesia's GDP at purchaser's price, provided by the World Bank.

Table 3. GDP of Indonesia (Source: (The World Bank, n.d.)

Year	GDP
2000	1.65E+11
2001	1.6E+11
2002	1.96E+11
2003	2.35E+11
2004	2.57E+11
2005	2.86E+11
2006	3.65E+11
2007	4.32E+11
2008	5.1E+11

2009	5.4E+11
2010	7.55E+11
2011	8.93E+11
2012	9.18E+11
2013	9.13E+11
2014	8.91E+11
2015	8.61E+11
2016	9.32E+11
2017	1.02E+12
2018	1.04E+12

The Indonesia's GDP also indicates overall increase from the year of 2009. With a slight drop from the year of 2012 to 2015, the GDP is back on increasing from 2016.

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4. CONCLUSIONS

Despite how the export ban of Indonesia is often described as a part of resource nationalism, as indicated by both the economic trade index and GDP, this export ban actually does not bring negative impact to the economy of Indonesia. The international world still perceives Indonesia to have a moderate freedom of economic, and the economic is actually still growing as the GDP grows.

However, as this is a preliminary study, further research is needed to determine the economic impact brought to Indonesia's economy by the export ban. Since the economic freedom index and GDP are simplified measures of the economy, more parameters are needed to better resolve the impacts of the export ban of raw mineral commodities of Indonesia.

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Syntheses, Characterization and Antibacterial Activity Test of Some Organotin(IV) 2-hydroxybenzoate

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Abstract: The syntheses of two organotin(IV) derivatives i.e. diphenyltin(IV) 2-hydroxybenzoate (**2**) and triphenyltin(IV) 2-hydroxybenzoate (**4**) have successfully been performed, tested and compared their antibacterial activities. The compounds synthesized were well characterized by means of spectroscopies of UV, IR, ^1H and ^{13}C NMR as well as based on microelemental analyzer. The bacteria used in the testing were *Staphylococcus aureus* and *Escherichia coli* by diffusion method. The results showed that all compounds tested were active in the antibacterial test giving the minimum inhibition concentration of 200 ppm (3.66×10^{-4} M and 4.11×10^{-4} M for **2** and **4**, respectively for both bacteria), while chloramphenicol was also giving inhibition concentration at the same concentration (6.19×10^{-4} M).

Keywords: antibacterial activity; *E. coli*; minimum inhibition concentration; organotin(IV); *S. aureus*

1. INTRODUCTION

Infectious disease has become very serious problem in the world as it has caused many deaths in developing countries^{1,2}. Giving antibiotics in the right dosage is needed to overcome this problem. However, in the last decade, the use of antibiotics is no longer effective¹ as well as the finding of antibiotics which is less behind compare to the bacterial resistance³. Thus, the finding of new antibiotics to overcome the infectious disease and antibiotics resistance are needed³⁻⁵.

One of the ways in an attempt to find the new antibiotics and antibacterial drugs can be done by developing the metal based drug of organotin(IV) compounds⁶⁻⁸. The organotin(IV) compounds are very interesting not only because their structure⁶⁻⁹, but most important due to their strong biological activities⁶⁻¹⁸. The organotin(IV) with carboxylate ligands have been found to be active as antifungi^{6,9,10}, anticancer and antitumor^{6,11-15}, antimalaria^{16,17}, anticorrosion activity¹⁸⁻²², and also as antibacterial^{2,8,23}.

The biological activity of organotin(IV) is influenced and depended on the type and number of organic ligands bound to Sn atom, although the organic attached is only secondary determinant⁶. Based on the fact that organotin(IV) compounds have been found to be active as antibacterial, in this paper we reported antibacterial activity of two organotin(IV) 2-hydroxybenzoate against *S. aureus* and *E. coli*.

2. MATERIALS AND METHOD

2.1 Materials

All reagents used were AR grade. Diphenyltin(IV) oxide ($[(\text{C}_6\text{H}_5)_2\text{SnO}]$), triphenyltin(IV) hydroxide ($[(\text{C}_6\text{H}_5)_3\text{SnOH}]$), 2-hydroxybenzoic acid were obtained from Sigma, sodium hydroxide (NaOH) and methanol (CH_3OH) were JT Baker products, and the control drug, chloramphenicol were used as received without further purification. Positive gram bacteria *S. Aureus* was obtained from laboratory of PGI Cikini hospital, Jakarta, *E. coli* was obtained from Integrated laboratory and innovation technology center, Universitas Lampung.

2.2 Instrumentation

^1H and ^{13}C NMR spectra were recorded on a Bruker AV 600 MHz NMR (600 MHz for ^1H and 150 MHz for ^{13}C). All experiments were run in DMSO- D_6 at 298K. The number of runs used for ^1H experiments were 32 with reference at DMSO signal at 2.5 ppm, while the ^{13}C were 1000-4000 scans with the reference DMSO signal at 39.5 ppm. Elemental analyses (CHNS) were conducted on Fision EA 1108 series elemental analyser. IR spectra were recorded on a Bruker VERTEX 70 FT-IR spectrophotometer with KBr discs in the range of $4000\text{--}400\text{cm}^{-1}$. The UV spectra were recorded in the UV region and were measured using a UV- Shimadzu UV-245 Spectrophotometer. Measurements were performed in 1 mL quartz-cells. Solutions were prepared using methanol as the solvent with concentration of $1.0 \times 10^{-5}\text{M}$.

2.3 Synthesis of organotin(IV) 2-hydroxybenzoate

The organotin(IV) 2-hydroxybenzoate compounds used in this work were prepared based on the procedures previously reported^{9,10,14,17,19-21,24}. These procedures were obtained as adaptation from the work available in the literature⁸. For example the procedure in the preparation of diphenyltin(IV) di-2-hydroxybenzoate was as follows:

0.866 g (3 mmol) compound **2** in 20 mL of methanol was added with 2 mole equivalents of 2-hydroxybenzoic acid (0.40.834 g) and was refluxed for 4 hours at 60 – 61°C. After removal of the solvent by rotary evaporator, the compound $[(\text{C}_6\text{H}_5)_2\text{Sn}(\text{OOC}_6\text{H}_4(\text{OH}))_2]$ which was obtained was dried *in vacuo* until they are ready for analysis and further use for antibacterial activity test. The average yields were more than 90 %. The same procedure was also adapted in the preparation triphenyltin(IV) derivatives, $[(\text{C}_6\text{H}_5)_3\text{Sn}(\text{OOC}_6\text{H}_4(\text{OH}))]$, one mole equivalent of 2-hydroxybenzoic acid was added.

2.4 Antibacterial Activity Test

Antibacterial activity test by diffusion and dilution methods were performed based on the procedures used previously in our group^{2, 24}. In this work the bacteria used were *S. aureus* and *E. coli*. The control positive used was chloramphenicol.

3. RESULTS AND DISCUSSION

Two organotin(IV) compound derivative namely diphenyltin(IV) di-2-hydroxybenzoate (**2**) and triphenyltin(IV) 2-hydroxybenzoate (**4**) have successfully been prepared by reacting the diphenyltin(IV) dihydroxide and triphenyltin(IV) hydroxide with 2-hydroxybenzoic acid based on the procedure available in the literature^{9,10,14,17,19-21,24}. The compounds synthesized then were tested and compared their antibacterial activities against *S. aureus* and *E. coli*. The microanalytical data of the compounds synthesized are tabulated in Table 1, the results in general are very good and close to the theoretical yield.

Table 1. Microanalytical data of the compounds synthesized

Compounds	Elemental Analysis found (Calculated)	
	C	H
2	56.64 (57.04)	3.62 (3.66)
4	60.78 (61.60)	4.04 (4.11)

Table 2. The λ_{\max} of the UV spectra of the organotin(IV) compounds

Compound	λ_{\max} (nm)	
	$\pi \rightarrow \pi^*$	$n \rightarrow \pi^*$
1	203	263
2	210	296
3	220	258
4	234	288

The analysis of UV spectroscopy gave λ_{\max} . Values from all compounds. The results are shown in Table 2. From these data, there are some important shiftings of for each compound. The two compounds gave two main characteristic bands from $\pi \rightarrow \pi^*$ and $n \rightarrow \pi^*$ transition. As example, in compound **1** the transition $\pi \rightarrow \pi^*$ was observed at 204 nm, in compound **2**, there were changes of λ_{\max} for $\pi \rightarrow \pi^*$ transition to longer λ_{\max} to 235 and 288 nm. The bathochromic shift is an indication that the substitution of ligand has occurred, i.e. oxygen atom in hydroxyl group has been replaced by oxygen atom in 2-hydroxybenzoate^{9,10,19-21,25}. The $n \rightarrow \pi^*$ transition in **3** was due to the presence of free electron pair of oxygen in carboxylic acid²⁵. Similar observations were also occurred for compound **4**.

Some important vibrations of IR spectra for the compound synthesized are presented in Table 3. The characteristic of compound **1** appeared at 729.3 cm^{-1} which is stretch for Sn-O bond. When **1** was converted to **2**, the new stretches at 1243.1 and 1242.6 cm^{-1} appeared and they were from Sn-O-C bond. This means the Sn-O bond in **1** has broken and new bond between Sn and oxygen atom in carboxyl group from 2-hydroxybenzoate has been formed. Other characteristic stretches were the present of C=O stretch at 1601.1 and 1688.4 cm^{-1} indicating the present of carbonyl in **2**²⁵.

¹H and ¹³C NMR data of the compounds synthesized are tabulated in Table 4. The careful analysis compared to the previous data has been done. In ¹H NMR, the chemical shift (δ) of phenyl proton bound to Sn atom as expected appeared in the range of 7.41-7.43 ppm, while the chemical shift of proton benzoate were at 7.75-8.85 ppm. The ¹³C NMR of the phenyl bound to Sn atom gave δ at 134.84-136 ppm and the carbon benzoate at 128-136. The chemical shift (δ) of carbon carbonyl as expected appeared at 166-167 ppm^{9,10,14,17,19-21,24-27}.

Table 3. Some selected and important IR band of the compounds synthesized

Compound	2	4	References (cm^{-1})
Sn-Cl	-	-	410-320
Sn-O	598.45	755.42	800-400
Sn-O-C	1289.2	1290.1	1250-1000
Sn-ph	1076.8	1074.6	1100-1000
C=O	1597.2	1624.7	1760-1600
CO ₂ sym	1690.1	1632.9	1500-1400
C=C	1479.3	1551.8	1650-1400
C-H Aromatic	3061.3	3069.2	3100-3000
OH	3437.4	3438.7	3100-3500

Table 4. ¹H and ¹³C spectra of the organotin(IV) compounds

Compound	H in phenyl (ppm)	H in benzoate (ppm)	C in phenyl and benzoate (ppm)
2	H2 & H6 7.52 (d,4H); H3 & H5 7.56 (t, 4H); H4 7.52 (t,2H)	7.70-7.90 (m)	C1-6 (phenyl): 129.3 – 128.6; C7 165.7; C8 131.4; C9 130.2; C10 134.0; C11 133.8; C12 130.0; C13 128.4
4	H2&H6 7.5 (d,6H); H3&H5 7.49 (t 6); H4 7.47	7.73-7.93 (d)	C1-6 (phenyl): 129.1 - 128.5; C7: 165.4; C8: 131.3; C9: 130.3; C10: 134.0; C11: 134.0; C12: 130.0; C13: 128.2

The result of antibacterial activities by diffusion method of the compounds (**2** and **4**) are shown in Table 5. This method has been used to find the most effective concentration as antibacterial agent. The ratio of inhibition zone against concentration of compound tested were evaluated to know their effectivity. The data revealed that the two compounds tested against the two bacteria, *S. aureus* dan *E.coli* produced various inhibition zone. The two compounds were active at concentration of 200 ppm or equal with 3.66×10^{-4} M for **2** and 4.11×10^{-4} M for **4**, the

starting materials giving much higher inhibition concentration.

Table 5. MIC values of all compounds tested compared with chloramphenicol

Compounds	Minimum inhibitory concentration (MIC) ($\times 10^{-4}$ M)	
	<i>S. aureus</i>	<i>E. coli</i>
Chlormaphenicol	6.19	6.19
2	3.66	3.66
4	4.11	4.11

The control positive drug, chloramphenicol was also giving inhibition concentration at 200 ppm (6.19×10^{-4} M) where its halozone was bit bigger compared to the compounds tested. The results reported here were quite similar to the previous results^{2,24}. These indicated that the compounds tested have been shown a promising result as new antibacterial drug²⁸.

4. CONCLUSIONS

We have successfully prepared two organotin(IV) compound with ligands of 2-hydroxybenzoic acid and tested their antibacterial activities against *S. aureus* and *E. coli*. The inhibition zone obtained was comparable to chloramphenicol as the control positive. Thus this finding opens the chance for these compound for future applications as antibacterial drug. However attempts to find stronger antibacterial drug is still on going in our laboratory in order to get the better new antibacterial drug.

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Effect of Calcium Carbide on Concentration of Trace Elements in Fruits Grown Within Kaduna Metropolis

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Abstract: The study examined the effects of calcium carbide as a fruit ripening agent on the concentration of trace element in Mango, pawpaw and banana. Calcium carbide was administered to 12 samples (mango, banana and pawpaw) at three different concentrations (1 g/kg, 5 g/kg and 10 g/kg of calcium carbide per kilogram of fruit) and control (0 g/kg). The samples were analysed for calcium, sodium, potassium, iron, arsenic and phosphorus using Flame Photometer, Atomic Absorption Spectrophotometer (AAS), and X-ray Fluorescence Spectrometer. The results obtained revealed that calcium carbide is a very good ripening agent with a ripening time of 2days (48 hours) among all the fruits (mango, banana and pawpaw at a concentration of 10 g/kg). The results of mineral elements in the artificially ripened fruits obtained showed highest value for calcium M_3 (10 g/kg) 2.671 ± 1.01 , potassium M_1 (1 g/kg) 7.750 ± 1.92 , sodium P_1 (1 g/kg) 0.169 ± 0.01 , iron B_2 (5 g/kg) 2.697 ± 0.12 and phosphorus M_1 (1 g/kg) 2.412 ± 0.05 ppm. Mineral elements were found in all fruit samples, but their concentrations were lower than the recommended daily intake (RDI). Calcium carbide administration as fruit ripening agent was shown to have insignificant rise in arsenic levels in fruits, but all the samples had increased arsenic levels from ND to <0.001 ppm which is below permissible limits of FAO/WHO (0.1 ppm). These results showed that even though calcium carbide may have significant fruit ripening ability, it also causes significant reduction in the fruit nutrients as well as increased arsenic level to certain amount. The consequences of this study indicate that fruits could be potentially used in alleviating micronutrients deficiency, especially for the Kaduna populace as a potent source of minerals. The daily intake of heavy metal (arsenic) through fresh fruits may not constitute an immediate health hazard, because the concentrations were below the maximum permissible limit but over time as a result of accumulation in the body system become a health hazard.

Keywords: Banana, Pawpaw, Mango, phosphorus, sodium, Iron, potassium and Arsenic

1. INTRODUCTION

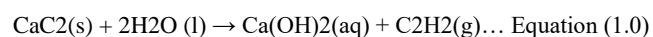
In common language usage, a "fruit" normally means the fleshy seed-associated structures of a plant that are sweet or sour, and edible in the raw state, such as apples, bananas, grapes, lemons, oranges, and strawberries. Botanically however, fruits include many structures that are not commonly considered as "fruits", such as bean pods, tomatoes and wheat grains. The section of a fungus that produces spores is also called a fruiting body (Dudley, 2004)

Fruits can be divided into two groups according to the regulatory mechanisms underlying their ripening process. Climacteric fruit, such as tomato, apple, pear, and melon are characterized by a ripening-associated with increase in respiration and in ethylene production, the phytohormone ethylene being the major trigger and coordinator of the ripening process (Korenovska, 2006). By contrast, non-climacteric fruits, such as grape, orange and pineapple, are characterized by the lack of ethylene-associated respiratory peak and the signalling pathways that drive the ripening process remain elusive (Adewole and Duruji, 2010).

In the process of hastening fruit ripening, chemicals and ripening agents are used by retailers and farmers in most developing countries such as India, Bangladesh, Pakistan, Ghana, Cameroon and Nigeria (Dudley, 2004). There are about fifteen (or more) artificial ripening agents available and practiced on one or more fruits. Natural taste and nutritional value becomes a casualty of the process. The fast ripening of fruits means they may contain various harmful substances (Singh and Janes, 2001).

Calcium carbide (CaC_2) is used as a ripening agent, though banned in many countries (Per et al., 2007). It is colourless when pure but

turns black to greyish-white in colour when contaminated by an impurity, with slight garlic-like odour. When it reacts with water, Calcium carbide produces acetylene gas (an analogue of ethylene) which initiates the ripening process. Equation 1 gives summary of the reaction.



Calcium carbide also contains traces of arsenic and phosphorus hydride. Acetylene prepared from calcium carbide also contains phosphine and arsine up to 95 and 3 ppm respectively. Calcium carbide is considered a strong reactive chemical with carcinogenic properties and is used as a gas for welding. Acetylene gas is flammable and explosive even in a low concentration compared to ethylene (Per et al., 2007).

Calcium carbide is a commonly used agent in the ripening process of fruits, though it is primarily used in welding purposes. Calcium carbide for the treatment of food is considered extremely hazardous, because it contains traces of heavy metals, arsenic and phosphorous. Acetylene gas may affect the neurological system by inducing prolonged hypoxia. Calcium carbide causes various health hazards like, headache, dizziness, mood disturbances, drowsiness, mental confusion, memory loss, cerebral oedema and seizures (Anwar et al., 2008). Other commonly used ripening agents are acetylene, ethylene, propylene, ethrel (2-chloroethylphosphonic acid), glycol, ethanol and some other agents (Per et al., 2007; Anwar et al., 2008).

In Nigeria, enormous quantities of fruits are produced but heavy losses are encountered before reaching the final consumers with estimates of fruit loss of about 60% (Carlos et al., 2011;

D’Mello, 2003). To mitigate this enormous challenge and to increase profitability as well, fruit farmers often pick the fruits when mature but not ripe enough for consumption so as to transport them without significantly jeopardizing their structural or nutritional qualities and then artificially ripens it before selling. As novel as this process is, it carries with it significant health concerns because not only is the fruit production processes unregulated, the farmers and fruit vendors often use industrial grade chemicals such as calcium carbide meant for welding processes as fruit ripening agents (Liu,2003). These chemicals may contain contaminants which pose significant health risks, it is imperative to investigate the residual effects of calcium carbide on some fruits so as to ascertain the dangers associated with the consumption of calcium carbide ripened fruits.

2. MATERIALS AND METHODS

2.1 Study Area

The fruit samples were collected at Albarka farms, Kaduna north local government area (figure 1).

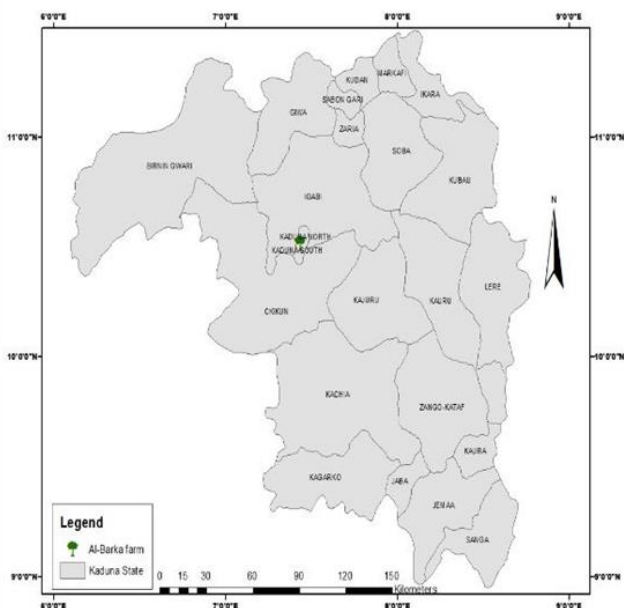


Figure 1: Map of Kaduna showing sampling location

2.2 Sample Collection and Preparation

Twelve (12) samples consisting of green but matured unripe banana, mango and pawpaw were collected from Albarka farm in Mando, Kaduna metropolis. These samples were washed with clean water, dried, weighed and kept in clean polyethylene bags before treatment with calcium carbide to induce the ripening process as described by Lopez et al., (2002) the calcium carbide was obtained from fruit sellers in Railway Station market, Kaduna.

2.3 Artificial Ripening of Fruits and Ripening Time

The calcium carbide was weighed using a weighing balance (Mettler AE 166 model) and divided into the weight requirement of each treatment group (1 g/kg, 5 g/kg, 10 g/kg and 0 g/kg calcium carbide per fruit) and then wrapped in a paper and kept at the bottom of a plastic container. The fruits (banana, mango and pawpaw) were packed according to treatment and covered tightly with a newspaper to prevent leakage of the acetylene produced. The calcium carbide was then moistened with a drop of water before placing the fruits in the container to release the gas. After 24 hours, the packets of calcium carbide were removed from the containers, and the fruits were uncovered and allowed to ripen. The fruit ripening time was measured as the time it took the whole

fruits (banana, mango and paw) to change colour from green to yellow (Subkola et al., 2010)

2.4 Samples Analysis

2.4.1 Determination of Trace Mineral Elements, Arsenic and Iron Composition

The method described by (AOAC., 2002) was employed for the determination of mineral content of the various fruit samples (banana, mango and pawpaw). One gram (1g) of each of the fresh fruit sample was placed in a crucible and heated in a muffle furnace at 550 OC for 6 hours. The resulting ash was digested in 10 mL of aqua regia (HCl + HNO₃ in ratio of 3:1) and heated slowly for 20 minutes. After heating, 100 mL of distilled water was added to the mixture before filtering. The filtrate obtained was transferred into clean labelled sample bottles and analysed using atomic absorption spectrophotometer for arsenic and iron concentrations while a flame photometer (Model FP 902 PG instrument) was used for the determination of sodium, calcium and potassium in the filtrate. X ray fluorescence was employed for determination of phosphorus.

3 RESULTS AND DISCUSSIONS

Table 3.1: Mineral Elements in Artificially Ripened Banana, Mango and Pawpaw with Calcium Carbide at Different Inclusion Levels

	Conc (g/kg)	Ca (g/kg)	K (g/kg)	Na (g/kg)	Fe (g/kg)	P (g/kg)
M	cont rol	1.58±0.09	1.75±0.78	0.194±0.01	1.579±1.01	1.801±0.35
M₁	1	2.333±2.15	7.750±1.95	0.153±1.00	1.952±1.98	2.412±0.05
M₂	5	2.110±0.12	7.350±2.00	0.122±0.01	2.181±0.01	1.001±0.00
M₃	10	2.671±1.01	7.201±0.01	0.119±0.99	0.245±0.53	1.524±0.04
B	cont rol	1.232±0.01	1.042±0.06	0.133±2.00	7.521±0.94	1.223±1.01
B₁	1	1.244±0.00	1.164±0.00	0.122±0.07	2.590±0.01	0.501±2.00
B₂	5	1.331±2.01	0.943±0.09	0.125±0.00	2.697±0.12	0.307±0.01
B₃	10	1.194±0.01	1.001±0.56	0.142±0.66	2.053±2.01	0.672±0.0
P	cont rol	0.095±0.92	2.012±1.22	0.095±2.00	1.081±2.01	0.221±0.5
P₁	1	0.384±0.09	2.851±2.01	0.169±0.01	0.442±0.00	0.794±0.00
P₂	5	0.495±1.04	2.064±0.01	0.016±0.09	0.372±0.00	0.503±1.00
P₃	10	0.281±0.07	3.954±0.01	0.102±0.98	1.034±1.00	1.304±1.12
R DI		1000	3500	2400	20.5	170

Key: M= mango, B= banana and P= pawpaw, 1 g/kg of calcium carbide per fruit, 5 g/kg of calcium carbide per fruit, 10 g/kg calcium carbide per fruit, RDI = recommended daily intake, control (0 g/kg of calcium carbide per fruit).

3.1 Discussions

The results of the mineral element analysis and concentration of Arsenic are presented in Table 1 and 2 shows that the artificially ripened banana, mango and pawpaw fruits with calcium carbide at different inclusion levels are as follows.

3.1.1 Calcium

High calcium concentrations were observed for the fruits treated with 1 and 5 g/kg calcium carbide but low values were observed for both 0 and 10 g/kg calcium carbide treated fruits. But all the results obtained showed that the calcium contents of all the fruits were below that of the 1000 mg/day recommended amount for calcium. Calcium is an important component of intracellular processes that occur within insulin responsive tissues like skeletal muscle and adipose tissue. Alteration in calcium flux can have adverse effects on insulin secretion which is a calcium-dependent process (Amit and Shailandra, 2006). Thus, the considerable amounts of calcium in the banana treated with 1 and 5 g/kg of calcium carbide as observed in this study, suggest the importance of these fruits to diabetics.

Calcium is a constituent of bones and helps the body to contract correctly, blood to clot and the nerves to convey messages. When the calcium supply to the body becomes insufficient, the body on its own extract the needed calcium from the bones. If the body continues to tear down more calcium than it replaces over a period of years, the bones will become weak and break easily. Calcium is essential for disease prevention and control and may therefore contribute to the medicinal influences of the fruits (Franke, 2006).

3.1.2 Potassium

The concentration of potassium in the artificially ripened banana, mango and pawpaw fruits with calcium carbide at different inclusion levels revealed that in the case of the banana fruits, the control had the least amount of potassium (1.75±0.78 ppm) while all the other treatments had values ranging from (0.943±0.09) to (7.750±1.92 ppm). The potassium levels showed no significant difference except for B₂ (treated with 5 g/kg calcium carbide) with a value of 0.943±0.091 ppm. Similarly, the findings of this research also showed similar trends in the pawpaw fruit samples but the treatment group administered with 10 g/kg calcium carbide had the highest potassium concentration of 3.954±0.01 ppm. In the case of sodium on the other hand, the controls (0 g/kg calcium carbide) had the highest amounts of sodium for both mango and banana fruits with values of 0.194±0.01 and 0.133±2.00 ppm respectively. However, low levels were observed for the control group in the case of pawpaw fruit (0.095±2.01 ppm). These results are similar to those obtained by Mahmud *et al* (2013) when they studied the mineral and heavy metal contents of some commercial fruit juices. Na⁺/K⁺ play a very important role in diet as it controls high blood pressure in the body. Studies had shown that lower sodium and higher potassium intake helps to reduce high blood pressure in hypertensive patients.

The recommended Na⁺/K⁺ ratio should be less than one. The report of this investigation revealed that regular consumption of fruits would help to prevent hypertension and might lower blood pressure in hypertensive patients. This result agrees with the finding of Hui *et al.*, (2006) who reported that fruits are good sources of diets for lowering blood pressure.

3.1.2 Iron

The results of concentration of iron in the artificially ripened banana, mango and pawpaw fruits with calcium carbide at different inclusion levels also showed similar trends to those of sodium and potassium where the controls had the highest amounts of 7.521±0.94, 1.579±1.01 and 1.081±2.02 ppm for banana, mango and pawpaw fruits respectively. Iron helps in the formation of blood and in the transfer of oxygen and carbon dioxide from one tissue to another. Iron deficiency usually leads to impaired learning

ability and behavioural problems in children, and also anaemia (Franke *et al.*, 2006)

3.1.3 Phosphorus

Table 1 also shows the phosphorus levels in the artificially ripened mango, banana and pawpaw fruits indicated there is no direct relationship between calcium carbide inclusion and phosphorus in both mango and banana fruits as the controls (0 g/kg calcium carbide) had more phosphorus than in the 1 g/kg calcium carbide treatment group. However, in pawpaw fruits, the results indicated that there was increase in phosphorus with higher inclusion of calcium carbide as the control had 0.221±0.558 ppm phosphorus while the 1 g/kg calcium carbide treatment had 2.412±0.054 ppm phosphorus. Phosphorus performs essential roles in the body, it is needed for energy metabolism, translating genetic information, maintaining cell membranes and regulating calcium, among other functions (Sajib *et al.*, 2014) Usually, the only people who have to worry about phosphorus are those with [chronic kidney diseases](#), especially those with kidney failure, since they have trouble removing it from their blood and excess amounts can be harmful though. There may be reason for healthy people also to be wary of getting too much phosphorus because the mineral can combine with calcium in the blood and form deposits in the muscles and other soft tissues, causing them to harden. Phosphorous can also interfere with the body's use of other minerals like iron, magnesium and zinc and can cause diarrhoea. In general, this typically occurs in people whose bodies have a severe dysfunction in the way they regulate calcium, or in those with severe kidney disease [17]. Animal studies have linked high phosphorus intake to a spectrum of health problems, including cardiovascular events, kidney impairment and [bone loss](#) (Amit and Shailandra, 2006)

Table 3.2: Concentrations of Arsenic in Artificially Ripened Banana, Mango and Pawpaw with Calcium Carbide at Different Inclusion Levels

Samples	Conc. (ppm)	Conc. of Arsenic (ppm)
M	control	ND
M₁	1	<0.001
M₂	5	<0.001
M₃	10	<0.001
B	control	ND
B₁	1	<0.001
B₂	5	<0.001
B₃	10	<0.001
P	control	ND
P₁	1	<0.001
P₂	5	<0.001
P₃	10	<0.001
FAO/WHO		0.1

Key: M= mango, B= banana and P= pawpaw, 1 g/kg of calcium carbide per fruit, 5 g/kg of calcium carbide per fruit, 10 g/kg calcium carbide per fruit, control (0 g/kg of calcium carbide per fruit), ND= Not detected

The results presented in Table 2 revealed that the arsenic concentration in the artificially ripened banana, mango and pawpaw fruits with calcium carbide at different inclusion levels showed insignificant increase in concentration in the arsenic level across the fruits with increase in calcium carbide administration. Arsenic is among the most toxic metals found in the environment. It has three valence states: As (0), As (III) and As (VI) (ATSDR, 2000). Inorganic form of arsenic is generally more toxic than organic form. Contamination of arsenic is also found in ground water which is also a serious problem encountered especially in third world countries (Lopez *et al.*, 2002; Gosh *et al.*, 2004). Arsenic in drinking water and food supply causes slow poisoning and risk of death in more than 100 million people worldwide. Consumption of Arsenic to a concentration measuring 60 ppm and above is lethal (Sambu and Wilson 2008). Acute doses of arsenic can cause tachycardia, acute encephalopathy, congestive heart failure, stupor, convulsions, paralysis, coma and even death (Onianwa *et al.*, 1999) Another study showed that repeated exposure to arsenic leads to peripheral neuropathy, cardiovascular distress, peripheral vascular disease, kidney and liver damage, hypertension, myocardial infraction and leukopenia (Jayana *et al.*, 2009). Chronic effects of arsenic include skin abnormalities, neurotoxic effects, chronic respiratory diseases, dementia, cognitive impairment, hearing loss and cardiovascular disease (Jayana *et al.*, 2009; Barnes *et al.*, 1995). However, from the results obtained the arsenic level for all the fruits (Banana, Pawpaw and Mango) were found to be (<0.001 ppm) which is below the acceptable limit (0.1 ppm) recommended by FAO/WHO signifying that there is no danger risk associated with the consumption of these aforementioned artificially ripen fruits.

4 CONCLUSION

The results of the mineral elements showed increase in calcium carbide administration and sodium content. However, potassium showed no consistent variance with increase of calcium carbide. Calcium carbide administration as a fruit ripening agent has shown insignificant rise in arsenic levels in all the fruits (banana, mango and pawpaw) with increased in calcium carbide level. However, the accumulation of arsenic in human body over time may gradually constitute a health hazard. It was observed that the naturally ripen fruits have a longer shelf-life than the calcium carbide artificially ripened element fruits.

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