THEVETIA PLANT ECONOMIC POTENTIAL: CHEMISTRY'S KEY POSITION

COURTESIES

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Great Unilorin Students,
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Ladies and Gentlemen.

INTRODUCTION

I give honour, adoration and glory to God Almighty for the unique opportunity to serve this great University as a pioneer member of academic staff and and for seeing me through today to give this inaugural lecture. I am doubly grateful to God and the University authorities for honouring me to give this lecture today, during a historic event, the convocation ceremony. Ordinarily, the inaugural lecture should have been shifted, but because the University Management and I believe the governing Council wish to honour me for whatever reasons they may have adduced. I remain particularly very grateful for this honour.

One common characteristic of plants and animals is life, similarly both plants and animals feed for survival. In most cases, animals feed on plants, this simple mode of feeding inter-relationship is referred to as herbivorous.

God at creation provided a model for the study of science and the perfect food chain model. God created the very basic essentials for life first i.e. air, water and light. Thereafter, He created plants and finally animals. Man was created as the king of animals and given the authority to take control over all He had created. Man exercises the control in progression as his knowledge of the environments, particularly plants, increases. As the population increased, survival challenges increased, adaptation and utilization of the plants for his good also increased. These conditions for survival called for better knowledge i.e. study of the plant, became more and more challenging. There arose a steady need to explore plants around him to his economic advantage.

Farming, in the simple concept, is the multiplication of a plant to meet the need of man, consequently increase in population demands increase in scope of farmland and farming technology. Farming also calls for selection of crop with preferred qualities, this accounts for man's activities whereby a crop native to a location readily gets migrated by man to a foreign land. The colonial explorers and traders who migrated in the early history contributed very largely for easy spread of plants from one region of the world to others.

Virtually all plants cultivated in plantations today were once plants that grew in the wild, in their natural environment. We are all familiar with fruit trees, e.g. mango and orange, palm trees, and other economic tress, how man has cultured each to maximize their plantations. Plantations today have developed beyond just large scale farming; care is given to selecting best variety for propagation.

Thevetia Plant

Thevetia plant is a tropical shrub which grows in the wild and remains ornamental, despite the abundance of the plant around our homes, schools and other buildings. The plant is grown as hedges and kept for its bright and attractive flowers. Thevetia plant is recorded to be more than 2000 years in its native countries – West Indies, Brazil and Mexico. It was taken to Europe about three hundred years ago, and today it has naturalized in virtually all countries in the tropics. Thevetia plant thrives very well in all the climatic and vegetation belts of Nigeria, it is readily found in Port Harcourt and in Maiduguri or Sokoto. To date, thevetia plant remains a plant of no economic value whereas it has a lot of potentials. This is the focus of this lecture.

Before I go into serious business of the lecture, Mr. Vice Chancellor sir, please allow me to introduce you to the plant of the lecture.

Thevetia Plant Morphology

Thevetia plant is a dicotyledon which belongs to the Aponaceae family. It is a composite, evergreen shrub, which is found to have a milky sap. It is native to West Indies, Mexico and Brazil. It is known as yellow oleander (nerium), gum bush, bush milk, exile tree in India, cabalonga in Puerto Rico, ahanai in Guyana, olomi ojo by Yorubas in Nigeria. The plant is a shrub, reaching a height of 3 to 3.9metres. The plant is perennial; the leaves are linear, narrow, sword-like and green. The flower is yellow flute which develops to a fruit which has a pair of follicles or drupes, it has one to four compartments, each containing a seed. The fruit when unripe is hard and green but gradually turns black as it ripens. The fruit has varying masses (2-6.1g) which are dispersed by man and propagated by seed or stem. The plant fruits virtually ten out of the twelve months of the year. The seed contains about 60 – 64% oil on dry matter basis. The plant produces white latex (sap) that is highly poisonous. The seed also is highly poisonous. This attribute accounts solely for the lack of interest in the development of the plant. In spite of the toxicity of the plant, it has found useful applications in several spheres of life. Its latex is used as an analgesic for toothache when the stem part is chewed in Juccata; and as an insecticide, the latex or extract of the stem as vesicant and the bark as a febrifuge and effective abortificacent. The wood is used as axe handle.

THE CHEMIST IN ACTION ON THE POTENTIALITY OF A PLANT

Curiosity is one dominant factor a natural product chemist possesses to explore his environment, particularly the plants. The plant everybody does not pay any attention to could readily engage the research interest of the natural product chemist. It is an in-built trait for a chemist to notice a peculiarity of a plant for his research and kick- start the study of the plant. On the other hand, a plant scientist of any discipline say, herbalist/pharmacist, agronomists/plant breeder, a nutritionist etc may, by questions in his area of interest on a certain plant material, stimulate interest of a chemist to pay attention on the plant. Even in the event of the latter, the chemist will only accept the challenge and do something meaningful if he is curious and zealous about the problem.

Every plant is a stored-up treasure (nature) God has provided for the exploration of man. It is like the inorganic mineral and crude oil deposits. The deposit remains a thing of potentiality until man ventures to explore it and analyze it for its constituent and adapt these to the advantage of man. The petroleum deposit in Nigeria did not get there after our independence. Indeed had the British government a good knowledge of the deposit and had explored this, our independence would have been delayed. All the same the exploration and development did not start until some people showed interest, invested money and energy. The Obasanjo administration had shown interest in the solid mineral exploration, this is the initial impetus; there remains a need for good implementation by all concerned. For now, most solid minerals in Nigeria still remain potential as far as their contribution to the economy of the country is concerned.

Like the solid minerals and crude petroleum deposits, every plant is a treasure that must be explored to give man maximum benefit of the plant. The plant, as we have studied at the elementary school, is made up of the leaves, stem, root and in most common plants, flowers and fruits. Many of the plants around us are used in their natural forms, deriving only basic and minimium benefits. Plants that have been explored by all scientific input have been developed at varying degree for varying level of benefits to man. It is common knowledge that a fruit tree produces fruits at its season, so its product is available for a short period even when the fruit provides valuable nutrients we need throughout the year. Unless the fruit is processed, the services derivable from the fruit shall be limited.

Plants influence the good life of man in various spheres such as in medicine, food and industry (agro allied industry). The plant however shall remain potential or partly developed until the chemist makes his contribution on the constituents of the plant. For instance, malaria was a deadly disease until the discovery of cinchona plant which contains quinine. The plant even after man's initial knowledge of its herbal proficiency certainly required the input of the chemist to identify the active ingredient and eventually work to supply and meet demand of the drug, quinine.

Scurvy was a disease that was ravaging among sailors and treated by taking fresh fruits. With the input of the chemists, vitamin C (ascorbic acid) was mass produced and put on hold the disease henceforth.

The role of the chemist goes beyond identification of the active ingredient in a plant; he is also saddled with the responsibility to synthesize the compound as a true replicate of that which the plant biosynthesizes. By this singular role, he can supply the populace beyond what the plant can, even if plantations are developed. Ability to synthesize helps to provide improved variety and new drugs and other chemicals in other applied fields.

Plants Position in the World Economy

Plants in various forms provide the raw materials for every agro—based industry. This sector accounts for a high percentage of the economy of every nation. Countries not endowed with petroleum deposit or mineral deposits have no option other than develop its agricultural sector to supply raw materials for the agro-based industries. Nigeria was in this position until the 70s when crude petroleum accounted for the foreign exchange of the nation.

Plants may be classified to include oil seed plants, which today contribute tremendously to the economy of all nations even the developed countries. Malaysia and Indonesia invested in the development of palm tree in the mid 50s, today this single crop/plant gives the nation a high percentage per capital and foreign exchange earnings.

Oils and fats are products of plants which produce fruits and majority of plant fruits/seeds contain oils/fats in varying quantities. A plant is referred to as an oil/fat seed plant when its oil/fat is worthy of extraction for one use or another.

There are about twenty major oil seed plants recognized worldwide today as oil seed plants. Nigeria is rated underdeveloped judged by the state of the development of its oil seed plants. Nigeria NIFOR has it on record to have provided the first set of palm oil seedling to Malaysia in the 50s. Nigeria was once rated as a world leading palm oil producing country up till the 80s. Since the discovery of the crude petroleum, Nigeria had abandoned the palm tree plantation and turned to import palm oil for its industries requiring vegetable oils. Nigeria climate and vegetations are best suited to develop almost all the following major oil seed plants - palm tree, coconut, groundnut, cotton, castor, sunflower, jathropha, melon, soybean, beniseed and shea butter. It is sad to note that Nigeria is not noted in the production of any of these among the first twenty leading producing countries of the world.

Basic requirements to the emergence of a plant as an economic plant

Every plant in the first instance grows in the wild. When man discovers one use for the crop or product of the plant, he invests energy, time and his saving to explore the potentialities of the crop. To achieve early dividend in the exploration, a combined efforts of each of the following agents must be coordinated: the research team (universities and research institutions), crop farmers association, government agents, industries and bankers. The emergence of a few selected oil seed crop plants from wild to economic status is highlighted in this section. Each plant is selected for at least one peculiar property worthy of development for an existing application. Whereas in the distant past, the emergence of a plant as an economic plant was basically dependent on the quantity of the oil, today oil yield is secondary, whereas individual characteristics now become prominent, as will be seen in the following four oilseed plants.

Jojoba[1]

Jojoba is a slow-growing perennial plant, native to the Sonora Desert of Arizona; California and Mexico. Its oils composed of liquid esters with major components 40 and 42 carbon wax esters. The plant was first commercially harvested in the US in 1982. Its plantations are being established in India, Australia, South Africa and the Middle East. Jojoba oil is specialty oil for use in cosmetic, this prospect excited researchers to reach higher heights for the promotion of the plant; its oil and oleochemicals. There are multi-tract approaches on the production of jojoba seed and oil. Productivity average in 1991 was 226 pounds per acre and it is projected to quadruple by 2010, going by the investment on the plant production in 2004.

Lesquerella[1]

The plant belongs to the mustard family and is native to North America. It is a potentially valuable source of hydroxy fatty acid, supplementing castor seed oil. It is seen as a potential drought – tolerant oilseed crop that could produce fatty acids for lubricants, plastics, protective coatings, surfactants and pharmaceuticals. One of its fatty acids is lesquerolic acids (14 – hydroxy cis – 11- eicoseneoic acid) a hydroxy fatty acid, similar to the castor oil derived recinoleic acid but two carbon atoms longer.

Meadow foam[1]

Meadow foam is a slow growing herbaceous winter, annual, wild flower, native to the Pacific North West. It is still at experimental and developmental stage as a good alternate seed oil. Its emergence success as a world oil-seed is hampered by the competition its oil faces in the world market. The high price of the oil and the need to increase yield is a major deterent. Good funding to farmers and research will facilitate early market impact.

Cuphea[1]

Cuphea belongs to the family lyathraceae, a wild plant which still must be domesticated to gain commercial value. Its oil is rich in medium chain fatty acids. It competes favourably in the market with coconut and palm kernel oils. The latter two are tropical plants. The oils are well adapted to the manufacture of soaps, detergents, surfactants, lubricants and related products. Its oil is a good source of capric acid which is currently obtained principally from petroleum source.

Mr. Vice Chancellor Sir, I wish to mention in passing at this point that for any plant to transform from wild to economic, concerted, collaborated efforts of various bodies must be supported by government policies and adequate funding.

Contributions of oils and fats in the world economy

Each oil seed crop contributes it quota into the world pool of oils and fats. Invariably oils and fats have uses first in the domestic sector as part of food, and then conversion to other products now called– oleochemicals – in the industrial sector. Soybean is one major oil in the oleochemical industry and has one of the largest adaptations and conversion products. Scheme 1 gives at a glance major new uses of soyabean in the oleochemical sector.

Scheme 1 New uses of soybean oil

	New uses						
Products	Soy ink	Soy toners	Plasticisers Competitizers	Soy protein adhesives	Biolubricant	soy oil	soy polyols
Products Markets	Printing Inks	copiers & laser printers	PVC, Plastic	wood adhesive	transports	cosmetic	plastics
Consumptions (M. Bush/Y)	100	20	100	150	100	1	100

Source: INFORM (2005) 16 (10) 660

Oils chemists and oleochemicals manufacturers with higher concern are ever becoming more and more anxious over rates of production vis-a-viz consumption and demand for oil and oleochemicals. The concern and anxiety comes from the ever increasing demand by the oleochemical sector for oils that primarily were once for food. If prices of food containing vegetable oils will not fly out of reach of the common masses, there must be matching new sources of oils that shall specifically be oleochemical concern only. Towards this general concern, Frank Gunstone[2] in his lecture at the Stephen Chough Award by AOCS in May, 2006 attempted to answer the question "will oil and fat supply meet oil and fat demand in 2007?" He used available figures for the 15 years (1990 to 2005 to consider what supply and demand will be in the next 15years i.e 2005 – 2020. He classified oils and fats uses into three categories. These three classifications have oils and fats distribution as 80:14:6. The ratio is changing rapidly, principally due to high demand for biodiesel alone. Table 1 presents the supply and uses of oils and fat in 1990 and 2005 based on 4 animal fats and 13 vegetable oils.

Table 1: Oils and fats: supply and usage (MMT)

	Supply	Food	Oleochemicals	Others
1990	80	64	11	5
2005	135	108	19	8

Source: INFORM (2006) 17 (18) 541.

World supply of vegetable oils and fats shall ever be on the increase, and with widening gap between supply and demand, because of the environmental advantages of oleochemicals over petro-chemicals. Furthermore, there is the threat that petroleum resource decline with daily pumping of crude pteroleum whereas there is ever encouraging increase in terms of man input in acreage available for oil seed crops production. Oleochemicals have a bright future, because of the belief in many quarters that after a while, quantities of oleochemicals will be cheaper than the petrochemicals. Furthermore, oleochemicals are environmentally friendly.

The greatest challenge for oils and fats in the oleochemicals demand remains biodiesel. It is Gunstone's forecast that the world demand for production of biodiesel in 2020 may be 40-50MMT; this in turn will demand from the world vegetable and animal oils and fats. Gunstone is his lecture also considered the world production and use of oils and fats in terms of population and quantities of oils and fats, he viewed the world as made up of three categories. The developed nations with a strong oleochemical industry but use of their oils and fats in food are less than the global average. New Zealand was taken to represent developed countries with strong agricultural activity but probably with no oleochemicals industry. Nigeria represents developing nations with populations greater than 100million. In this third category, there is growing demand for food fats and oils. Table 2 presents per caput use of oils and fats (kg/yr) for all purposes in selected countries in 2005 (the world average is 21 MMT for 6,454 million persons.

Table 2: Per caput use of oils and fats (kg/yr)

Country	Population (Million)	Kg	Country	Population	kg
EU-25	456	50.8	China	1,299	19.6
USA	380	49.0	India	1,097	11.7
New Zealand	4	38.2	Indonesia	225	18.2
Russia	141	22.2	Brazil	184	25.1
Mexico	106	25.9	Pakistan	161	19.4
Nigeria	130	13	Bangladesh	152	7.5

Source: INFORM (2006) 17 (18) 54-2

Biodiesel: a major consumer of world oils and fats

Biodiesel is methyl ester of fatty acid. It may be produced by batch or continuous process represented in the two equations for reactions involved.

(a)(i) Fat/oil + NaOH $\longrightarrow$ RCOONa + glycerol
soap

(ii) RCOONa + MeOH $\longrightarrow$ RCOOMe + NaOH
biodiesel

(b) Fat/oil + MeOH $\longrightarrow$ RCOOMe + glycerol
Biodiesel

Biodiesel production at the present day volume is relatively recent, but that not withstanding, it is experiencing very dramatic expansion in the developed countries for classification of national development, it is almost an index. The need for the commodity, which is preferred to diesel, serves as a great driver for success in the sector. The drive is greatly supported by high price arising from artificial scarcity and fear for future real scarcity of petroleum diesel.

According to the US National Biodiesel Board, the number of active and proposed biodiesel plants grew by more than 67% in six months in 2005[2]. Projected production capacity for 2005 was 545 million gallons per year. As the capacity of biodiesel production increases, there shall be a corresponding increase in demand for oils and fats. In USA, soybean is the favorite oil, because it is easily available and the ease of processing it into biodiesel. Even in the developed nations, there is an aggressive drive for alternate seed oil feedstock for biodiesel, in particular. This is in anticipation of a major need of biodiesel by internal combustion engines; a justification for source in unorthodox new oil seed crops world over.

Palm oil and palm kernel oil: the plant oil wealth neglected by Nigeria

Malaysia purchased its first palm oil seedling in mid 50s from NIFOR. In less than 50 years after, Malaysia and Indonesia led the world in the production of palm oil and palm kernel oil. In 2002, Malaysia produced 37MMT crude palm oil and 11.9 MMT of crude palm kernel oil[3]. Today Malaysia has the largest oleochemicals capacity of any country in the world and her capacity represents 25% of the world capacity in 2002. 16 oleochemical companies were in operation in Malaysia with a total production capacity of 1.756 MMT. About 1.4MMT of these oils were processed in to oleochemicals and 1.27 MMT of these products (89%) were exported. Major oleochemicals exported were fatty acids, fatty esters, fatty alcohols and glycerine. Oleochemicals from Malaysia have been exported to over 100 countries, including north America, European Union countries, Japan and China. It is worthy to note at this point that the volume of trade to Nigeria on the oleochemicals and crude vegetable oils is negligible, not worthy of mention, yet Nigeria imports a lot of its oleochemicals for the few oleochemical industries in the country possibly mainly from Malaysia and Indonesia. Furthermore, Mr. Vice Chancellor Sir, it is pertinent to remark at this point that Nigeria has greater potentialities to have been producers of oleochemicals which now compete effectively with petrochemicals. We have potentials to produce, but painfully we have neglected this ability. In no distant future, we shall have to import biodiesel to supplement if not replace our petroleum diesel then at a high price and a major drain on the economy of the nation, what a pity this will be to us then as a nation.

THE JOURNEY IN THE STUDY OF THEVETIA PLANT

The plant grows with widespread in Kwara state. The abundance attracted my attention to consider what could be made of the plant; so literature review was conducted to obtain information on quantity of studies done so far on the plant. In all, literature report was very scanty, which means very limited work has been reported on the plant; even then, the little reports available were on the toxicity of the latex, and the seeds.

The first experiment[4] was organized to study the impact of fertilizers on the seedlings, this involved pots experiments on effect of NPK, calcium, potassium, and phosphorus. The result of the studies revealed that application of NPK, single superphosphate, calcium nitrate, and murate of potash had effect on the uptake of nitrogen, potassium and calcium, particularly after seven weeks of application. Whereas the fertilizers rich in calcium tended to depress uptake of potassium and nitrogen, application of CAN, however, tended generally to enhance, more significantly, uptake of calcium.

The plant was thereafter studied for the properties of the seeds which the plant produces abundantly yearly. The seed is 60-65% oil and 40-45% protein. These two parameters stimulated us to embark on aggressive studies particularly on introducing it as a good substitute to orthodox supply of oils used by the commercial soap making industries.

The oil physical properties, particular its saponification value, 120-124, and unsaponifiable matters, 0.24-0.41% prompted us to study it in soap making. Tables 3a - c present some information on the oil compared with other orthodox commercial oils.

Table 3a: Sterol content of a few selected seed oils (%)

Fat/Oil	Sterol content (%)
Coconut	0.06 – 0.08
Cotton	0.20 – 0.31
Linseed	0.37 – 0.42
Palm	0.23 – 0.31
Palm kernel	0.06 - 0.12
Groundnut	0.19 - 0.25
Rapeseed	0.35 - 0.50
Soybean	0.09 - 0.11
Wheat gem	1.3 - 1.7
**T. Peruviana*	0.44 -1.40 (plus phospholipids)

* Fadipe V.O., 1992 MSc. Thesis

Table 3b: Oil seed mean oil content of a few selected seeds.

Type\source	AOCS Ac – 44	Exhaustive extraction AOCS 2-93
Soybean	19.35	21.98
Rape seed	43.74	43.5
Cotton seen	18.17	20.61
Sun flower	12.71	46.10
Safflower	37.99	38.0
* Groundnut	21.24	
* Lasquerella	25	
* Varnonia	40	
- T. peruviana	60-64	

Source: INFORM (1997) 8 (10), 1048; Ibid (1998) 9(8) 749-835; (1999) 2 (5) 686 – 691.

- Result in the department

Table 3c: Oil composition of selected seeds

Type/Source	Sat	Mono unsat	Poly unsat
Soybean	15	24	67
Cotton seed	24	26	50
Palm	52	38	10
Palm kernel	86	12	2
Sun flower	11	20	69
Coconut	92	6	2
Ground nut	18	49	33.5
* *T. peruviana*	30-45	46-51	1-3

Source: INFORM (1990) 11 (4) 250

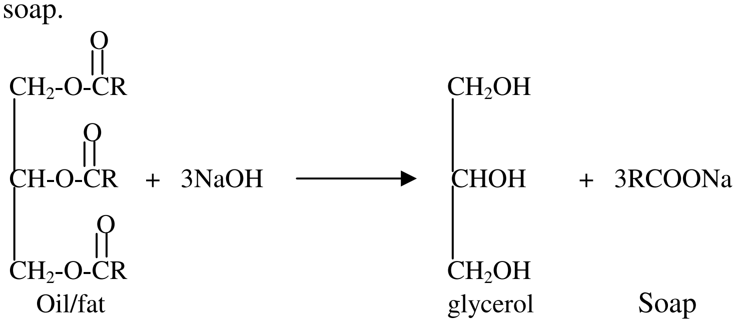
* Ibiyemi *et al*[5].

The first and oldest[6] oleochemical is soap. This is a product of saponification of vegetable oils and fats. It is believed to have been produced by the ancient Egyptians through Phoenician into the Rhone valley in France as early as 600BC. In 23-79 AD, Plinus, described soap as hair pomade which was made from a combination of fats and ashes. At the early uses, soap was not a cleansing agent. About 130-200 AD, Galenos, a Roman doctor, discovered the cleansing property of soap. In 17th

Century, the general use of soap for cleansing and bathing first started when Justus V.Liebig (1803-1873) gave a citation that "soap is an index of the prosperity and culture of any nation". This simply means that soap in the days was used to compare two nations with the same population and to ascertain which one is richer, more prosperous and better cultured.

The first type of soap in Nigeria is the black soap[6] which was milder, creamer and foam better than some imported soaps as at the time under review.

The basic principle and process of soap making remains practically unchanged for the past 1000 years. This involves saponification of oils and fats with alkali and salting out of the soap.



Guided by the high level of the oil in the seed coupled with the abundance of the plant with its widespread in the country, the team including Mr. S.A. Akanji decided to study the oil of the seed starting with saponification reaction. Towards this goal, several kilograms of the fruit/seeds were processed to obtain some gallons of the oil. In the first instance, samples of the oils were made available for undergraduate students at their practicals to conduct saponification reaction to obtain soap. The performance of the oil at this level prompted us to provide the Production Manager of Lever Brothers Nig. Ltd, Apapa (now Unilevers Nig. PLC) one gallon of the oil for soap trial production in 1981. The Production Manager was very enthusiastic in accepting the oil and indeed, in a very short time reported back to us his findings. The oil was very good in production of soap that was suitable for bar and toilet soap.

There was no need to bleach the oil before use, thereby saving processing cost, and the lathering property was appropriate. We considered the finding as good grounds for the department's breakthrough in its interaction with an industry.

In 1978, December 4-7, a symposium sponsored by UNESCO was held in Toronto, Canada, and a team of twelve chemists led by Prof. Ekong DEU, attended. The theme was university – industry interaction in chemistry in Africa. The useful thrust of the symposium is for members of the university chemistry departments to forge a close relationship with chemical-based industries in Africa. So the finding by the production manager was to have signaled an opportunity to record success of the aims and objectives of the Toronto symposium. But low and behold this was not the case as the relationship broke down with the Production Manager questions, "what quantity (kilogram or gallons) of the oil we expected will be produced from one hectre of the crop plantation"? We have never thought of this because we saw ourselves concerned with the chemistry of the oil not the agriculture and economics. That not withstanding, however, to keep the relationship alive, we suggested that we needed one thousand naira to engage the services of labourers to keep one acre of farm to be planted at the beginning of the next rains. The production manager was frank and quick to let us know that such request is not common and would require management decision. All other follow-up proved abortive and so terminated the much cherished and anticipated celebration of break-through with an industry.

The disappointment was taken as a challenge and we sought alternative means to determine the yield of oil per acre, if the plant was grown on a semi large scale. The team of chemists did not see itself handling this assignment effectively, so talked with our colleagues in the crop production department, Faculty of Agriculture to accept to place final year project students on the scheme. All our efforts yielded no response. So we ventured into acquiring a plot in the Faculty demonstration farm for the project, there was no success recorded.

In 1992/93 I was away on sabbatical leave in ABU, Zaria, and I enjoyed the favour and cooperation of Prof Daniel Sarror, the Vice Chancellor, who was good to grant me a special fund for the project. The farm management, under the chairmanship of Prof Duro Olarewaju, made a plot available for my project. At the beginning of the rains, 1000 seedlings were planted and kept until the expiration of my sabbatical leave in September 1993. There was no staff collaborating and the plants were to flower in 1994, it was not convenient for me to maintain the project. Thereafter I moved to Ilorin consequently and painfully the farm was lost to weeds.

During the period I was in Zaria, I organized an MSc student and an academic staff, Mr. J.O. Ojokuku, together with Mr. V.O. Fadipe, an MSc student of University Ilorin to do a comparative study of the plant seed oil obtained from seeds collected in Ilorin, Edidi, Zaria and Enugu. I was briefly in Enugu on WAEC assignment and I noted a variety of the plant with purple flower rather than yellow. This peculiarity attracted my attention for comparative studies of its oils with others with yellow flowers. The results of analysis of the seeds on the varietals based on the number of kernel per seed and geographical location are presented in table 5.

Table 4a: Summary results of analysis of the four varieties of seeds

Analysis Data	**One-seed**	**Two-seeds**	**Three-seed**	**Four-seed**
% oil yield	56-61.1	59-63.1	54.58.8	54-59.3
Saponification value	121-140	124-186	120.181	120-196
Unsaponifiable matters (%)	0.27	0.21	0.42	0.38
Free fatty acids	0.488	0.434	0.564	0.513
Acid value	0.97	0.86	1.12	0.02
Peroxide value	16.46	14.47	19.97	19-41
Iodine value	76-.	81.2	80.2	79.2
Refractive index	1.461	1.462	1.462	1.462
Specific gravity	0.926	0.913	0.927	0.937
Viscosity (cent)	19.00	21.36	15.80	17.04

Source: Ibiyemi *et al*[5]

Table 4b: Common fatty acids present in oils of the varieties of thevetia seeds based on kernel number and geographical locations.

Location Variety		C14:0	C16:0	C16:1	C18:0	C18:1	C18:2	C18:3	Sat	Unsat
Enugu	1	0.31	17.7	0.10	5.2	46.1	-	0.7	23.35	46.86
	2	0.37	19.3	0.35	6.02	40.38	15.57	0.7	25.72	57.98
	3	0.48	18.4	0.18	6.31	39.94	13.12	0.9	25.10	56.16
	4	0.43	20.9	0.30	7.00	36.74	8.47	-	28.29	79.57
Edidi	1	0.56	14.2	0.3	5.01	34.06	13.85	1.35	19.78	51.58
	2	0.17	20.6	0.3	7.75	40.85	8.85	0.12	28.22	50.11
	3	0.72	16.0	0.20	5.48	34.12	10.76	0.16	22.65	45.21
	4	0.31	19.81	0.27	6.56	36.58	7.95	1.34	76.05	46.15
Ilorin	1	0.31	20.42	0.25	7.35	45.06	12.58	0.44	28.90	58.33
	2	0.17	18.34	0.21	5.28	30.44	14.05	1.33	23.79	46.03
	3	0.17	21.00	0.91	7.20	43.39	14.08	0.45	28.27	58.71
	4	0.32	15.97	0.21	5.80	33.76	16.97	0.71	22.09	57.65
Zaria	1	0.14	20.81	0.24	8.01	45.79	16.81	0.36	28.96	56.78
	2	0.16	23.70	0.23	8.97	40.96	12.65	0.60	34.93	54.44
	3	0.22	20.12	0.35	7.39	47.00	14.77	0.47	27.73	62.49
	4	0.38	20.21	0.28	7.63	40.00	16.00	0.49	28.22	62.71

Source: Ibiyemi *et al*[5]

Enugu has the highest rainfall over 10 months, Zaria with lowest rainfall, while Edidi and Ilorin lie in-between in amount of rainfall, and period of rains. Seeds from Ilorin and Edidi record highest oil content (62-64%), Zaria 58% and Enugu 61%. In terms of quality of the oil, Zaria seeds contain highest unsaturation (59.3%) and Enugu lowest value (51.1%).

Basic research, in general, in most purposes and intent, provides data that would guide the applications of the material being investigated. This principle guided our plan of actions on the analysis of thevetia seed oil, i.e. to accumulate as much data on its physical and chemical properties, peradventure, some day this will adapt the oil for an industrial use. Towards this goal, the oil was studied for its thermal stability[7]. The result obtained showed characteristic changes in physicochemical properties when heated at 180°C, 200°C, and 220°C, over a period of 15 hours. There was no significant difference in the five parameters (iodine value, acid value, peroxy values, saponification value and amount of polar compounds) studied for the three working temperatures. The study proved that the seed oil would be stable to heating, therefore could be good for cooking, if adopted for use in frying food. This property also shows justifications for the oil to be used or converted for use in the making of lubricants and greases.

Synthetic Lubricants: Thevetia seed oil and its chance.

Synthetic lubricants came into use during the World War II in Germany, primarily due to lack of petroleum. However, their use today is based on specific applications where conventional petroleum base-lubricants fall short of the desired requirements, primarily in the area of low and high temperature performances. Table 5 presents some compound classes that fall into the category of lubricants from vegetable oils and fats.

Table 5: Types of synthetic lubricants

Class	Typical compound
Fatty acid esters	Ethylstearate
Dibasic acid esters	Dibutylphythalate, di (-2-ethyl hexyl tricresy phosphate)
Silicone esters	Tetraethylsilicate, hexa(-2-ethyl butoxyl disiloxane
Polyglycols	Poly(propylene glycol)
Poly alkyl and aryl ethers	Poly phenyl ethers

The combination of chemically compactable thickening agents with either petroleum oil or synthetic fluids results in greases. There are greases which are soaps and non-soap types. The soap-types contain the metal salt of organic acids, while the fatty acids (non-soap) greases are usually palmitic acid, and other saturated fatty acids.

Thevetia seed oil was therefore investigated with a view to establish its suitability in preparing a lubricant or grease since it has good thermal stability properties. Several project students were placed on the modifications of the seeds oil. Like any other seed oils, thevetia seed oil responded favourably to several chemical reactions but analysis of the products to establish the products was truncated by lack of facilities even as elementary as separation techniques beyond plate and column chromatography.

At this point it may be mentioned that the university had purchased an equipment vital for our studies of vegetable oils, GLC, but the equipment is not adequately equipped to perform, for lack of standards. All efforts made since 2004 to acquire the standards directly from SIGMA in UK, and then through ZAYO, the sole agent in Nigeria, based in Jos, is yet to yield fruit, despite payment for the standards in pound sterling and naira.

Thevetia seed oil, like any organic liquid, could be considered worthy to be tried for production of emulsion. Emulsion could be cosmetic or lotions, depending on various factors that may include the presence of more than one phase, stability, or the phenomena of surface activity. Thevetia seed oil was investigated peradventure it will make good varnishing creams, an essentially oil-in-water emulsion with its fatty acid salts as the emulsifying agent. Stable emulsions of the oil were prepared but the qualities other than stability could not be established.

Thevetia biodiesel: Its chances as a seed oil

The world is daily seeking to substitute petrochemicals in general, but most specifically biodesel and other engine combustion fuels. The first use of vegetable oils[8] in internal combustion engines dates back to about 1900 when Rudolf Diesel (1858-1913) experimented with groundnut oil and Fujio Magao achieved operation with pine oil in 1948. The two oil-price sharp increases (1973) sparked world-wide desire in developing energy sources as alternate to petroleum in internal combustion engines, boilers and other combustors. Effort since then, has stimulated investigations in favour of use of ethanol in Brazil, sunflower oil in South Africa[9], rape seed oil in Europe, and currently, and on a large scale spent cooking oils and vegetable oil esters are gaining acceptance and use at a surprising scale. For almost ten years, Malaysia and Indonesia tend to lead the world by the nose by virtue of its success story in biodiesel investments and production. Malaysia in 2005 announced a national biodiesel policy to stimulate the development of the biofuel industry by four-prong strategy that encompases the production of a biofuel blend of 5% processed palm oil and 95% petroleum diesel (B5), encouraging the use of B5 among the public and establishing biodesel plants in Malaysia for the export market[10].

Our research team which kept changing as the research students graduated made coordinated planning very weak and inefficient. This not withstanding, thevetia seed oil has been studied to provide data on its conversion to biodiesel. Production of its biodiesel involved both batch and continuous processes. All available analytical techniques have been used to establish a level of success in the esterification reactions. The most reliable confirmation of the success should have come from NNPC; however we have lately approached LUBCON for this. Samples of our biodiesel were made available to NNPC Kaduna in 1993 for analysis. The "no response" was taken as negative results, but at the same time we needed their response on what to do to achieve success. Of recent, our effort, whereby we investigated the effects of catalysts on our production of biodiesel has taken us to LUBCON to determine our level of success. Samples have been presented to LUBCON; the result of analysis is being awaited. Since LUBCON is close and more cordial, there will be close interaction and we hope to have success through this in the near future.

Thevetia seed oil in livestock feed formulation

The oil, if freed of the toxins of the plant, and the plantation developed, and the oil is not used as cooking oils, it may serve as oil component in the livestock feed meal formulation. The team led by Prof. J.O. Atteh[12] had the first trial on the replacement of palm oil by thevetia oil in broiler chick diets. In the experiment, the effects of replacing 0, 25, 50 or 100% of the dietary palm oil (5%) with oil of *Thevetia peruviana* seed was investigated using broiler chicks 0-3 weeks old. Increasing the content of thevetia oil in the diet reduced average feed in-take and weight gain ($P<0.05$) and decreased protein and fibre retention ($P<0.05$) and fat retention ($P<0.01$). However, there was no significant effect on feed: gain ratio or mortality rate. It was concluded that there was a need for further processing of the seed oil before it can be used effectively as an ingredient in broiler feed.

On our part, we have established that the oil indeed requires refining. Charcoal treatment removes all taint colour and recently we have confirmed the presence of the plant toxins in the oil. A repeat of the trial feed experiment with the refined seed oil is desirable, depending on the cooperation of our colleagues in the animal science department.

Thevetia seed oil in the paint industry

The utility value of the seed oil is unlimited, so the seed oil was considered possible alternate oil for the paint industry.

D.N. Meyer, sometimes in 2004, invited the department to a round-table discussion on what the department could do to source a local alternative alkyd, the major ingredient in the paint formulation; an item if replaced by local sources would reduce production cost. The alkyd accounts for about 50% of all ingredients compounded to make gloss paints.

Table 6: Typical recipe for gloss paint formulation

Ingredients	% Weight
Alkyd resins	49.6
Talcum powder	21.9
Turpentine	15
Titanium dioxide	17
Cobalt naphthenate	6.6

Source: Turner[13]

Soybean oil accounts for one of the major ten seed-oils currently in use by major paints manufacturing companies world-wide. Nigeria, to-date, imports every bit of its alkyds, a vegetable oil polyester. The chemical reactions basic to the preparation of alkyds are presented in the following equations.

1. Esterifications:
   $$R'COOH + ROH \longrightarrow R'COOR + H_2O$$
2. Etherification of polyols (a possibility):
   $$ROH + R'OH \longrightarrow ROR' + ROH$$
3. Transesterification:
   $$RCOOR^1 + R^2COOR^3 \longrightarrow R^2COOR^1 + RCOOR^3$$

The alkyd is a resin, synthesized from a dicarboxylic acid such as phthalic anhydride or its acid and a polybasic alkanol e.g. glycerol, pentaerythritol etc in the presence of a suitable catalyst at about 220-240^oC. The reaction is a condensation reaction and produces polymers. It is believed that the properties such as rapid drying, good flow, and excellent weathering. They have almost completely outstripped drying oils e.g. linseed oil, as binder for paints e.g. enamel, varnishes, wood primers and lacquers.[14]

The percentage of oil can be varied giving rise to short alkyd resins when the oil content is low and long alkyd resins when oil content is high. Typical alkyd resins' ingredients contents are presented in table 7.

Table 7: Classification of alkyds based on the amount of oil content

Parameter	Long alkyd	Medium alkyd	Short alkyd
(%) oil	>70	50-70	<50
phthalic anhydride (%)	20-30	25-35	35-60
Viscosity (Sec)	90-120	120-150	150-700
Acid value	12 max	30 max	32 max

Source: *Martens C.R. (2003) Alkyd Resins. Reinhold Publishing Corp. N.Y. Pp 108.*

The impact of the properties of the oil and performance of the paint is presented in tables 8 (a) & (b)

Table 8a: Effect of oil on alkyd properties

Oil Type		Coating Properties		
	Iodine value	Speed drying	Colour retention	Gloss retention
Linseed	180	↑	↓	↑
Tuna	170			
Dehydrated castor	155			
Safflower	140			
Segregated				
Conton seed	130-140			
Cotton	110			
Tall oil	125			
Soybean	135			
Ground nut	108			
Castor	85			
Olive	85			
Coconut	90			

Source*: Kirk–Othmer (1963) Encyclop of Chem Techn.2nd Ed-Intersci. Publ. JohnWiley & Sons Inc. NY Pp851-882*.

Table 8b: Division of each drying and semi drying oils into short, medium and long oil resins categories

Drying oil resins	short oil resins	Cure at elevated temp, give very hard, glossy finishes Used in finishes for appliances, signs and toys.
Drying oil resins	Medium oil resins	May be air dried or heated, give durable glossy finishes. Used for farm hardwares and metal furniture
Drying oil resins	Long oil resins	Have good brushing characteristics, dry rapidly in air, reasonably durable, glossy film Used in house-hold paints.
Semi-drying resins	No division based on oil length	Give film with improved resistance to yellowing on ageing. Used particularly for high gloss white finishes
Non-drying resins	Short oil resins	Used mainly in conjunction with amino resins. Give improved adhesion and flexibility. Used in storing finishes for appliances.
Non-drying resins	Medium oil resins	Used mainly as plasticizers for cellulose nitrate for furniture finishes.

Source: Deffar D and Soucek MD (2001) Journal Coat Techn 73 (919) 95

Thevetia seed oil has properties comparable with the common oils being used in the preparation of alkyds; we therefore embarked on the preparation of the alkyds, if only in response to D.N. Meyer's challenge. There are three teams of members of staff in the department who have accepted the challenge and have studied at least four seed oils in alkyd resin preparations and characterization of the alkyds. Alkyds have been prepared from thevetia seed oil, jathropha seed oil, dehydrated castor oil, tobacco seed oil and parinary seed oil. Tables 9a-c presents findings on the alkyds of thevetia and jathropha seed oils.

Table 9a: Solidification time of thevetia seed oil and jathropha seed oil

Alkyds			solidification time (sec)		
(i)	(ii)	(iii)	(i)	(ii)	(iii)
JAK-1	T-AKD-1	P-AKD-1	150	132	109
JAK-2	T-AKD-2		186	180	-
JAK-3	T-AKD-3		294	207	-
JAK-4	T-AKD-4		300	240	-

JAK– Jathropha alkyds; T-AKD - Thevetia alkyds; P-AKD – Parinary alkyd.

Table 9b: Viscosity of Alkyds

(i)	(ii)	(iii)	(i)	(ii)	(iii)
JAK-1	T-AKD-1	P-AKD-1	140	210	190
JAK-2	T-AKD-2		97	100	-
JAK-3	T-AKD-3		92	105	-
JAK-4	T-AKD-4		86	85	-

Table 9c: Drying characteristics of alkyd resins containing no drier

Out-door DFT	Indoor DFT	Outdoor STTT	Indoor STTT
JAK-1 T-AKD-1	JAK-1T-AKD-1	JAK-1 T-AKD-1	JAK-1 T-AKD- 1
5.3* 16.8/28+	11.6* 20/31+	51.8 4.8/15+	70.1 8.7/19+
JAK-2 T-AKD- 2	JAK-2 T-AKD-2	JAK-1 T-AKD-1	JAK-1 T-AKD- 1
10* 21/38+	16.5* 28/45+	99 10/24+	125 14/27+
JAK-3 T-AKD-3	JAK-3 T-AKD-3	JAK-3 T-AKD-	JAK-3 T-AKD-
19.8* 39/50+	25.3* 44/55+	113 12/23+	149 16/34+
JAK-4 T-AKD-4	JAK4 T-AKD-4	JAK-4 T-AKD-4	JAK-1 T-AKD-1
26.5* 41/55+	31.7* 48/65+	16.1 18/37+	17.5 19/42+
P-AKD	P-AKD	P-AKD	P-AKD
19.2	24	5.67	8.5

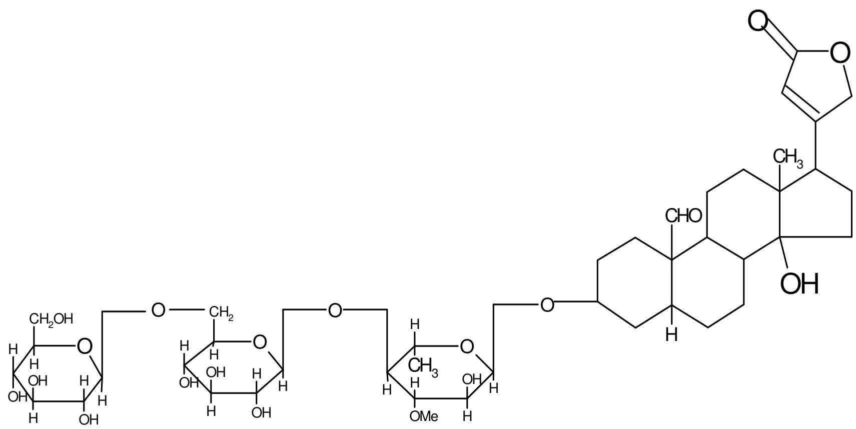
DFT = Dust-free Time, STTT = Set-to-touch-time

Source: Akinwatimi (2006). B.Sc.Project.

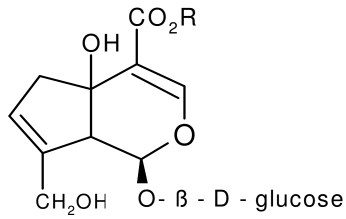
Seeds processed all over the years would have produced testa, if allowed to accumulate, would have amounted to several kilograms, which if it is not properly disposed could readily be an environmental nuisance of the type similar to saw dust in sawmills and palm kernel shell in palm kernel processing industry. On careful consideration, we thought that the testa could be considered for board-particle production. Samples therefore were sent to the Africa Timber and Plywood, Sapele in 1987. The product made out of the material was very hard and brittle. The industry indicated no further interest in the experiment, otherwise we would have wanted to have a blend of the hard material with a soft material, particularly, baobao fruit testa. (See appendix for the letter from the MD).

Thevetia seed: providing protein in animal feeds

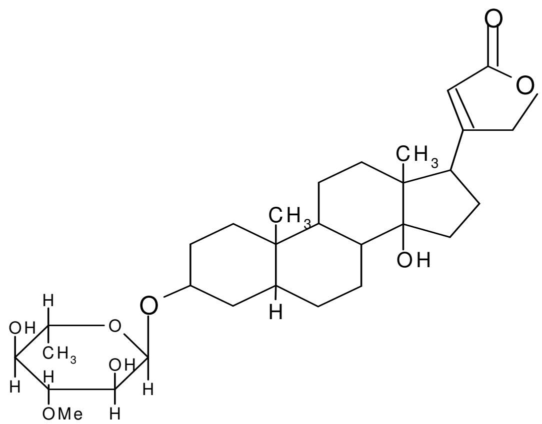
The seed on the basis of its protein content (40-45%) should be preferred to most orthodox protein sources in the formulation of animal feeds. Brain *et al*[15] and Bisset[16] were among the first few to report on the seeds for its toxins, cause of death as recorded for two children, horses and other animals. Compounds I to IV below serve as representatives of the toxins.



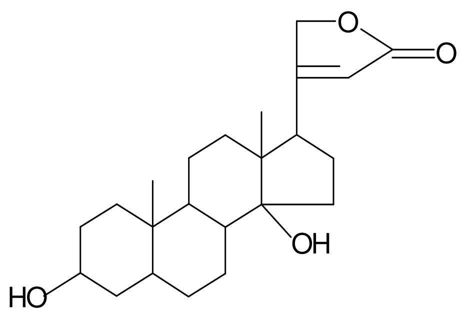
Thevetin A



(Theveside: R = H; Theveridoside: R = Me)



Neriifolin



Digitoxigenin (Thevetigenin)

The seed is shown to contain between 3.6 and 4% thevetin[17], the major glycoside of the seed, and the most lethal toxin. It is cardiotonic. Other compounds that have been identified are cerberin, ruvoside, perusitin and neriifolin[18]. Paper chromatography reveals that fresh seed of the plant contains fifteen compounds. Some of the glycosides have been subjected to clinical trials, especially in the treatment of congestive heart failure[19] and cardiac insufficiency. However the margin between toxic and the therapeutic doses have been found to be too small for many of the glycosides, especially thevetin, to be useful therapeutically until further research is done in this regard. Some of the compounds have been commercialized by ALDRICH chemical company. This already paves way for possible use of the extract when the seed will eventually be processed in large quantities.

In favour of the plant emerging as a possible commercial plant is the fact that other useful compounds have been isolated from the plant, these include flavonones and flavonols glycosides, extracted from the leaves of *T.peruviana*

The presence of anti-nutrients in oil seeds is not sufficient reasons to neglect a plant with prospect as the case with thevetia plant. There are not many seed that are free of anti-nutrients or toxins of any one type. The quantity and lethal level of the agent and ease of removal matter. Soybean, cotton seed and castor seed in their raw forms are all intolerable to majority of animals, particularly monogastric animals. Processing each under specified conditions have been adopted in the detoxification of such seeds. Irradiation is well established and properly utilized to effect genetic re-engineering, thereby producing improved variety of plant and animal types. This could lead to variations of contents of seeds and could be effective detoxification technique.

In the first set of detoxification treatment, dilute strong alkaline solutions and dilute hydrochloric acid were used separately and detoxification monitored by the level of bitterness of the cake. The cake with minimum bitterness was used to compound broilers meals containing 0,5, 10 15% thevetia cake.[20] Inclusion of thevetia cake in broiler diets, irrespective of level of inclusion, drastically reduced feed intake and weight gain (P<0.01) at both the starter and finisher stages. The results showed that both methods of detoxification are not efficient and sufficient. In pursuant of effective detoxification of the seed, other methods adopted include acid leaching using solutions at pH 6-9, organic solvents extraction, followed by aqueous ethanol extraction. Another method employed activated charcoal and boiling at varying periods ranging from 1 to 5hrs. Table 10 presents cardiac glycoside contents of the raw cake and cakes after various treatments.

Table 10: Cardiac glycosides content of thevetia cakes

Sample	Total cardiac glycoside
Raw seed cake	4.27 ±0.44% or 4.27g/kg
Acid treated cake	0.22 ±0.71% or 2.25kg/kg
Ethanol treated cake	0.08 ± 0.25% or 0.83g/kg
Charcoal treated cake	0.24 ± 0.22% or 2.4g/kg

Source: Oluwaniyi et al[21].

Charcoal treatment and ethanol extraction have been found to be more efficient and effective in the detoxification/debiterisation of the seed cakes. Acid hydrolysis prior to ethanol extraction also proved to be efficient but residual acid tended to leave a sharp taste that may not be desirable. The work of Finnigan and Lewis[22] using acid hydrolysis followed by ethanolysis to remove glucosinolates as food component in the rapeseed provides support that our results are as reliable and efficient methods of detoxification process[21]. The detoxification effectiveness was further established by a measure of the remains of the cake by monitoring the quality and quantity of protein in the cake, peradventure, protein may also have been extracted, along with the glycosides. Loss of protein would negate the primary objective of securing a good alternate protein source.

Variations in the time of extraction, volume of ethanol and quantity of cake were investigated and products obtained analyzed for the protein content[23]. Results obtained are presented in tables 11a & b.

Table 11a: Glycoside (%) extracted using varying ethanol: cake ratio

Time (hrs)	10:1 Ethanol: Cake	15:1 Ethanol: Cake	20:1 Ethanol: Cake
0.00	5.44	5.44	5.44
0.75	0.61	0.48	0.58
24	0.56	0.48	0.48
48	0.52	0.45	0.24
72	0.46	0.32	0.24

Table 11b: Moisture and Protein content of cake after extraction.

Time (hrs)	10:1 Ethanol: Cake		15:1 Ethanol: Cake		20:1 Ethanol: Cake	
	Moisture	Protein	Moisture	Protein	Moisture	Protein
0.75	17.24	64.92	12.10	69.09	15.80	65.92
24	16.95	65.76	11.13	68.91	15.63	66.05
48	16.09	63.45	12.80	68.91	15.80	66.34
72	18.00	65.77	12.89	68.58	15.46	65.91

Source: *Oluwaniyi & Ibiyemi*[23]

Table 12c: Effect of varying water in ethanol on the quality of cake using 15:1 ethanol: cake for 72 hrs

% Ethanol in water	Moisture Content (%)	Protein Content (%)	Glycoside Content (%)
50	25.89	62.13	5.44
60	22.82	65.35	0.49
70	15.35	67.98	0.45
80	13.39	68.95	0.32
90	14.44	65.50	0.32
100	15.89	62.35	0.32

Source: *Oluwaniyi*[22]

Results in graphic form in Fig. 1(a) and (b)

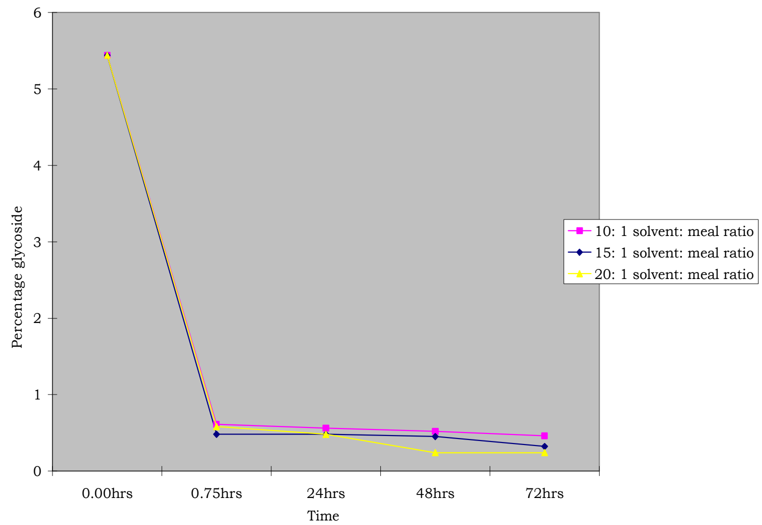


Fig 1a: Extraction of cardiac glycosides from thevetia seed meal by 80% aqueous ethanol/methanol mixture.

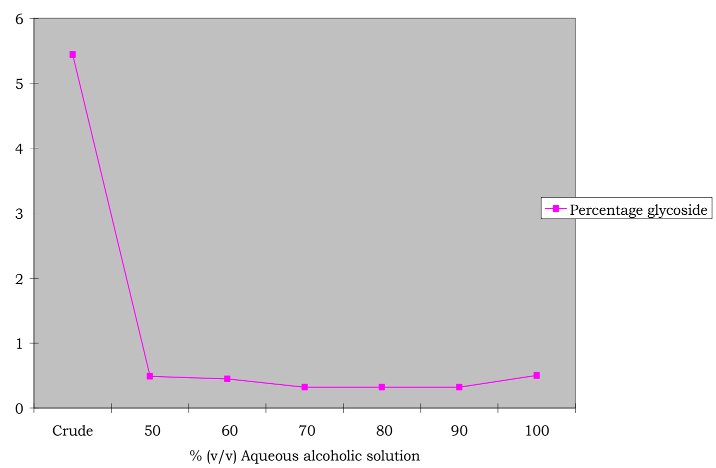


Fig 1b: Extraction of thevetia glycosides using varying concentrations of aqueous alcohol at 15: 1 solvent to meal ratio for 72 hrs.

The best adjudged treated cake was formulated as feed meals and fed to chicks to establish the efficacy of the detoxification technique. The feed experiments results are presented in figures 2a & b.

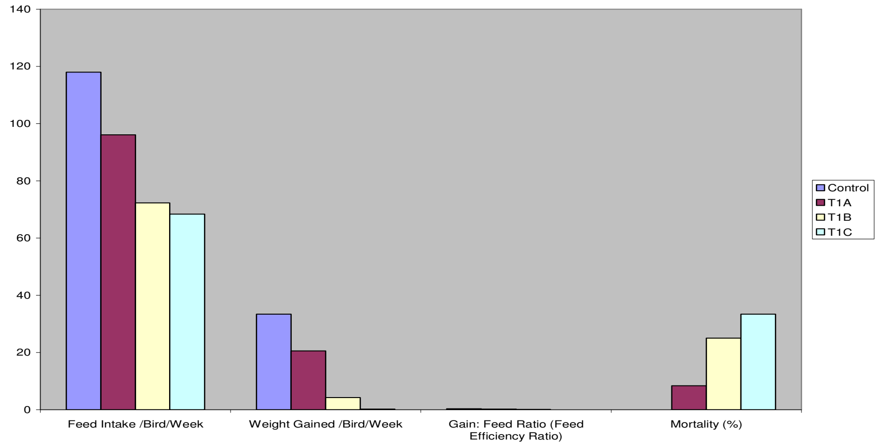


Fig 2a: Performance Pattern of birds fed acid detoxified TSM

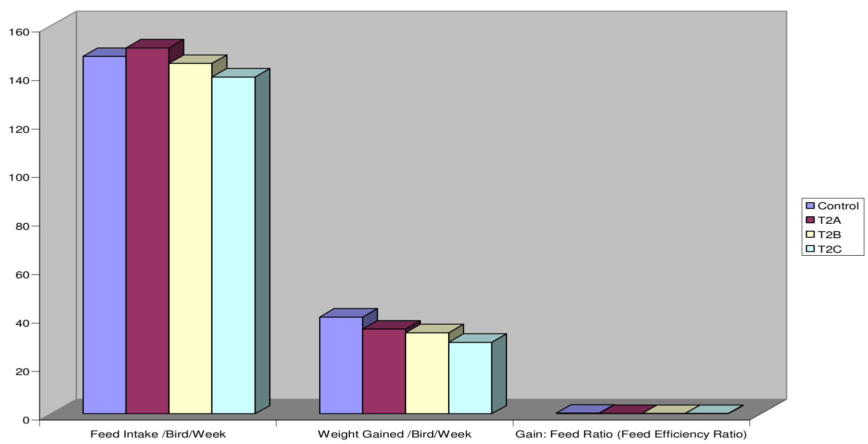


Fig 2b: Performance pattern of alcohol detoxified TSM

Result obtained from detailed analysis of the blood samples for birds fed each of the meals corroborated the result presented above from chemical analysis of the meal performance.

The qualities of the detoxified seed cake were further established by the analysis of the seed cake for the protein content and amino acids profile.

Table 13 presents the amino acids profile of the raw cake, and each of the two treated cakes. The efficiency of this ethanolysis by all standards is confirmed even by this parameter to be more efficient and effective in the detoxification exercise.

Table 13: Amino acids profile of the seed cakes

Amino Acid	Seed Cake		
	Raw	Acid treated	Ethanol treated
Alanine	4.49	3.04	4.56
Arginine	4.48	4.25	5.19
Aspartic acid	19.85	21.86	20.34
Cystine	1.69	1.05	1.69
Glutamic acid	14.21	20.10	15.67
Glycine	3.63	2.24	3.70
Htistidine	1.62	1.39	1.65
Isoleucine	2.94	2.09	2.97
Leucine	5.49	4.88	5.59
Lysine	4.47	3.97	5.65
Methionine	0.88	0.64	0.90
Phenylalanine	3.38	3.22	3.70
Proline	4.24	3.85	4.49
Serine	3.93	3.12	4.00
Threomine	2.61	2.04	2.67

Source: *Oluwaniyi*[22]

The result agrees with the report by El-Adawy and El-Kadousy[24] that ethanolysis led to an increase in the total, essential, basic, and aromatic amino acids of the seed cake detoxified.

Irradiation has been put into divergent uses in various aspect of life including agriculture; it has been widely adopted for genetic re-engineering to produce improved varieties in plant and animals. This technique is imagined could influence genetic variation that may effect the reduction and possibly elimination of the glycosides-toxins of thevetia plant.

Thevetia seeds and kernels were subjected to 100 rads, 300 rads and 500 rads treatment (100 rad=I Gray when (GY) is equal to IJK/ kg. Rad = radiation absorbed dose). Some were analyzed, some planted and plants produced monitored within the limit of chemists abilities for effect of the irradiation. Result obtained on chemical analyzed of the seeds is presented in Table 14.

Table 14: Monitoring effects of Co-60 gamma rays on the oil content of four sets of seeds based on kernel number variety.

Seed Type	Oil yield (%) of the types based on number of kernel/seed				
	One-seed	Two-seed	Three seed	Four seed	Average
Untreated /raw kernel	41.00	43.30	58.80	54.20	54.32
100 rad kernel	68.40	61.54	61.30	63.63	63.71
300 rad kernel	50.80	50.00	50.80	48.80	50.50
500 rad kernel	40.00	59.60	46.80	41.87	60.00

Source: *Akinduro (1999) BSc. thesis*

This result seems to suggest that seeds treated at 300 rad contain lowest oil content, an undesirable result, if the plant would be selected and nurtured after irradiation. The study of the plant morphology for seeds irradiated at the three doses however, suggests contrary performances. Table 15 presents results of the seeds harvest from plants grown from seeds with each of the three doses. Furthermore, the canopy size of the plants right from the 6^{th} month till the 24^{th} month provided convincing evidence in favour of 300 rad treatment. Plants from 500 rad seeds were dwarf, majority grew to about half the size of others and such were never able to flower and fruit, even in the fourth year.

Table 15: Summary results of the profile of fruits and seeds from thevetia plants (treated and untreated seeds).

Average	Seed-type (i) unirradiated (ii)300rad treated (iii)500rad treated (using 20-30 plants per plot)		
	(i)	(ii)	(iii)
Number fruits /plant	610	876	300
Weight of total fruit /plant (g)	230.5	204.3	198.69
Weight of kernel	5.72	7.25	4.86
Weight of fruit	11.45	14.00	12.31
Seed population distribution based on kernel/seed			
Type1	13	12	15
Type2	16	15	14
Type 3	17	16	15
Type4	4	4	6
oil yield (Pet ether extract of seed cake (%)	54.46	62.40	47.00
Chloroform extract of Seed cake (%)	2.10	1.70	2.00
Ethanol extract of seed cake (%)	1.57	1.30	1.49

Source: *Alabi (2004) B Sc thesis*.

The apparent contradiction in the results obtained by workers in 1999 and 2004 lends credence to the team conviction that as chemists we should limit our concerns with analysis of products provided by plant scientists and / or agronomists. Furthermore, irradiation effects on plant may not manifest and stabilize in the first or even second filial. i.e the changes anticipated may emerge in latter generation. The desired modifications may therefore manifest slowly.

Another monitoring conducted on the effect of the irradiation of the seed with 300 rads was to analyse cakes prepared from seeds harvested as first filial generation of plants treated and untreated seeds. The results obtained for the amino acids analysis are presented in tables 16a & b

Table 16a: Amino acid analysis of thevetia seed cakes

Amino acid	T1	T2	T3	T4	T5
Alanine	4.49	3.04	4.56	2.90	4.39
Arginine	4.48	4.25	5.19	2.99	4.87
Aspartic acid	19.85	21.50	20.34	144.88	19.17
Glysteine	1.69	1.05	1.69	1.37	1.61
Glutamic acid	14.21	20.10	15.67	16.77	15.01
Glycine	3.63	2.24	3.70	2.00	3.59
Hitistidine	1.62	1.39	1.65	1.03	1.69
Isoleucine	2.94	2.09	2.97	1.78	3.00
Leucine	5.49	4.88	5.57	3.84	5.7
Methiomine	0.88	0.64	0.90	0.50	0.79
Phenylalanine	3.38	3.22	3.70	2.28	3.30
Proline	4.74	3.85	4.49	2.95	4.30
Threomine	2.61	2.04	2.67	1.91	2.50
Tyrosine	2.49	1.94	2.49	1.66	2.49
Valine	4.01	3.57	4.01	2.48	4.01

Table 16b: Distribution of amino acids on basis of group

Analysis	**T1**	**T2**	**T3**	**T4**	**T5**
Total Amino acids	84.41	83.35	89.27	65.54	84.88
% Difference	-	- 0.66%	+ 5.76%	-22.36%	+ 0.56%
Essential amino acids (%)	35.4	31.07	36.22	32.00	35.65
Acid amino acids (%)	40.35	50.04	40.34	48.29	40.27
Basic amino acids (%)	17.55	16.05	19.02	15.91	19.34
Sulphur amino acids (%)	3.04	2.73	2.90	2.85	2.83
Aromatic amino acids (%)	5.87	5.16	6.19	4.64	5.79

Source: *O. O. Oluwaniyi (2007) Ph.D thesis (in progress)*

T1 = crude (untreated thevetia seed cake)
T2 = acid detoxified seed cake
T3 = ethanol detoxified seed cake
T4 = Charcoal detoxified seedcake
T5 = 300 rad treated seed cake

Table 16(b) reveals that detoxification processes by ethanolysis and radiation are worthy of further and detailed studies particularly irradiation effect on toxin level. Amino acids make up proteins. There are different members of protein depending on the sequence of the amino acids. Major classifications are globulin, albumin, prolamin and to lesser extent and of limited occurrence is gluten, majorly sourced from wheat. Solubility properties of the protein members are presented in Table 17.

Table 17: Protein classification based on solubility.

Protein	**Soluble medium**
Albumin	Water
Globumin	Salt solution
Prolamin	70% ethanol
Gluten	Alkaline solution

Proteins of the seed cakes have been analyzed for the various protein types; globulin and albumin have been established in various proportions. There are indications, subject to confirmation, that gluten may be present in an appreciable quantity that may justify intense research of the seed for its protein content, for gluten in particular.

Table 18a: albumin and globulin content of thevetia seeds

Cake HCl treated			Cake NaOH treated			Cake $Ca(OH)_2$ treated			Cake NaCl treated		
Extractant: protein(%)	Alb	Glb	Extractant: protein(%)	Alb	Glb	Extractant: protein (%)	Alb	Glb	Extractant: protein (%)	Alb	Glb
0.5M	0.6	0.50	0.2M	0.26	0.21	0.5M	2.63	2.61	0.5M	0.98	0.76

Table 18b: Composition of individual member proteins in seed cake

Type/member	Content %			
	Untreated	Irradiated	Detoxified	Irradiated & detoxified
Crude total protein	53.3	53.11	54.25	53.14
Albumin	11.70; 10.41*	12.89 -	13.88; 16.06*	10.24
Globulin	1.07; 7.65*	5.98	8.84; 5.66*	2.06
Gluten	15.62; 13.94*	14.38	12.54; 10.28*	15.84
Prolamin	4.56; 2.81*	2.38	0.99; 0.93*	0.85

* Result from two different procedures

In the event that gluten is unequivocally confirmed to be present as indicated in table 18b and in a quantity comparable to its presence in wheat, this singular parameter may be sufficient to achieve the vision for the emergence of thevetia plant as an economic plant. Table 18a provides good information on the protein isolates of thevetia seed. This prompted us for further study of the protein fractions.

CONCLUSION

We have studied *Thevetia peruviana* plant seed from as many points of view, believing we have accumulated as many pieces of information and data that should encourage scientists of related disciplines, particularly agronomists to show sufficient interest and work to bring out the potentialities of the plant. The plant deserves to be studied to establish it valuable prospects other than ornamental.

Mr. Vice Chancellor sir, I wish to inform this august gathering that I have presented a poster paper at the annual conference of American Oil Chemists Society held in Quebec, Canada, May 12-15th 2007 with the purpose to stimulate interests of chemists worldwide on the study of the seed for its oil and the seed cake. The plant, if given the right quantum of research and funding, could by 2015 be on field trials and its oil and cake available in commercial quantities as a major feedstock for any of the oleochemical and livestock feed meal industries.

RECOMMENDATIONS

Mr. Vice Chancellor sir, I wish to let you know that I have specifically sent special invitation letters to persons who should be in good knowledge of the research efforts on *Thevetia peruviana* plant for one reason or another. Invitees include the presidency, Raw Material Development Council, a few selected paints industries, Soap /detergent industries, cosmetic industries, flour mills; the Permanent Secretary of Federal Ministry of Education, Secretary of NUC and MD of NNPC and LUBCON. These people I have specially invited with belief that each, if sufficiently informed and convinced of my vision for the plant, are strategically placed to promote:

(i) research with focus on the plant,

(ii) promote the right relationship for healthy interaction between industries and university research on vegetable oils and fats in general and the plant in particular,

(iii) fund research in a satisfactory quantum,

(iv) appreciate the need for good and guided policies, political will, and drive in Nigeria to invest NOW specifically in the study of thevetia plant and in general in the production of vegetable oils and fats in Nigerian to make Nigeria contribute its quota effectively in the world struggle for production of oleochemicals.

To achieve the stated objectives, Nigeria research needs good and well articulated polices of the Federal Government and NUC shall steer the ship of research to ensure the right drive for good production of vegetable oils and fats in Nigeria. If the federal government shall popularize and provide necessary incentives to the farmers as has been done for cassava in the last five years, the country doors to foreign investors are certainly wider and more attractive in the production of oleochemicals than we got on cassava. A very major drive in processing any crop is production cost of the crop within a short period. Nigeria is well suited to produce vegetable oil to storm the world market within five years if it can be focused on the well established annual oil crops- e.g. soybean, sun flower, melon in addition to thevetia seed. If Malaysia and Indonesia have excelled as world leaders on two major oils- palm oil and palm kernel oil, within 20years, Nigeria with the same oil plants and at least ten others has better potentials that can readily make it be the leading not just one of the leading oleochemicals producers by 2020, a period oleochemicals may take over from petrochemicals, when the latter may be less relevant.

Mr Vice Chancellor, Sir, please allow me to suggest the following specific recommendations that I belief will put the economy of Nigeria on a sound footing and rank Nigeria economy at par with what obtains in the developed nations.

1. **Government** should provide policies and legislations for the creation of:

(a) Oil farmers association to ensure production of a target volume of the commodity in the short, medium and long terms,

(b) A governing council to work for the establishment of a viable oleochemicals production in Nigerian with a target time for its product to be available in the Nigeria and subsequently the world markets,

(c) A fund that derives its source directly from the crude petroleum sale to foster the activities set up in (a) and (b) above

2. **National Universities Council** should:

(i) Create and enforce compliance of a new policy on interdisciplinary research in preference over and above individual research in the universities. It should also provide guidelines whereby a minimum of say 10% of fund allocated to Universities shall be devoted to research studies,

(ii) Constitute a monitoring unit to ensure compliance in the investment of research grants in every university,

(iii) Work discretely through a committee of NUC/ industries to promote university research and industries interaction through healthy collaborations between the two bodies and with adequate funding by the industries,

(iv) Fill the gap between Raw Material Development Council, and the universities through a committee of the Governing Council for the RMDRC and NUC. The committee should give premium to collaborative interdiscipline research in the universities with sharper focus on direct and immediate relevance on the life and developmental efforts of the nation.

3. **The universities:** Universities in Nigeria should create a special central account specifically designated for equipment that shall function and be properly maintained thereafter to render useful services. In addition:

i. every University shall have a virile consultancy division to foster a healthy and productive University-Industrial relationship and attract necessary funding for research in the university,
ii. every university senate shall constitute its committee to seek and develop appropriate links with universities outside Nigeria for exchange of research information and collaboration on uses of facilities that make up for short falls in Nigerian universities. The committee shall mandatorily give reports, at least once, every academic session to the senate on its progress.

In my final submission sir, Mr. Vice Chancellor, the primary objective of the University is to provide unbiased intellectual leadership for the development of the nation. Thevetia plant is a challenge for the University of Ilorin to place Nigeria in the world map as a pacesetter in the studies of thevetia plant so that by 2015 it shall be an economic plant. It is an achievable target and I sincerely plead with the University of Ilorin management and Governing Council to accept the challenge to act positively. Towards this goal, sir, distinguished ladies and gentlemen and particularly my special invitees, captains of industries, please accept this very special recommendation as worthy of immediate implementation. That the University of Ilorin Governing Council should establish THEVETIA PLANT SPECIAL RESEARCH FUND into which every stakeholder in Nigeria shall subvent generously. The fund shall ensure success of thevetia plant research studies such that the University of Ilorin shall be “World Centre of Excellence on Thevetia Plant Development”. It is an achievable feat worthy of careful consideration.

Thank you and God bless you for your attention.

ACKNOWLEDGEMENT

To God be glory, honour and adoration for His goodness, mercies and for making today a reality.

God has made so many people to work to make today a reality. I am sincerely grateful to all the people that God has directed to contribute in any one form no matter how small.

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Relations, social associates, Christian friends particularly and many Muslim friends have been supportive in very many ways.

Members of my family beginning with my wife have endured so much, I thank you for your understanding and endurance when you have missed me physically and when I have been tight financially because I must succeed in my studies. The honour and joy of today belong to all us.

Thanks to all who have come today in response to my special invitation. You are great and the benefits that will accrue from the challenges of the lecture certainly remain your great reward.

God bless you ALL.

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