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Research Article

Design of a Safe Way to Harvest Palm Wine Without Climbing Trees

Michael Okeke Obaji*

Department of Electrical & Electronic Engineering, Ebonyi State University, Abakaliki, Nigeria

Abstract

Palm wine is a sweet, nutritious milky juice tapped from palm trees. In Southern Nigeria, especially the South East populated by the Igbo tribe; no ceremony, especially traditional marriage, can take place without palm wine. This has made palm wine tapping to become a lucrative trade. However, its production or tapping requires the tapper to climb tall trees to harvest the palm wine. This has made it unattractive to young people due to the fear of the tapper falling to death from such a scary height. Across the southern Nigeria and the middle-belt where this palm wine elixir is deeply appreciated, the population is over 150 million. This makes the palm wine tapping a huge business that needs modernization through innovative technology. Interestingly, the palm trees are littered in every community spanning from the Southern Nigeria to the middle-belt, making it a reliable raw material source, which makes the business certainly sustainable. In this innovative research, a vacuum-tubing technology (VTT) designed to suck the palm sap through the application of a suction force within a high pressure-versus-low pressure environment, between the tree trunk and the vacuum pump, is presented. This is intended to assist the tapper harvest the palm sap without climbing the tree.

Keywords

Palm Wine, Palm Tree, Harvest, Vacuum-tubing, Vacuum Pump, Igbo Tribe, Nigeria, Technology

1. Introduction

Globally, palm trees are counted among the oldest flowering plants (Redhead 1989) [18]. There are various species of palm trees that have been tapped across the tropical world in order to produce fresh juice, fermented drinks, palm syrup and sugar.

In some parts of Nigeria, palm trees are felled for wine harvesting, while the common practice is to climb the tree and harvest near the inflorescence. To access the sap, an incision close to the inflorescence is created through carving, using a sharp knife. The incision point is heated with naked flame for at least every 24 hours. This is to prevent the decay of the incision area which could attract infection from insects and microbes. The sap exudes from the incision area into the gourd (gallon) [11, 12].

*Correspondence: Michael Okeke Obaji (obajimo@yahoo.com)

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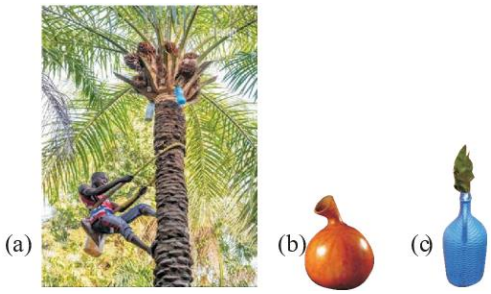

Figure 1. *(a) Wine tapper (b) gourd (c) gallon.*

There are five major economic palm tree species in the world. They are:

1) Coconut (Cocos nucifera)
2) African Oil Palm (Elaeis guineensis)
3) Date (Phoenix dactylifera)
4) Betel nut palm (Areca catechu) and
5) Pejibaye (Bactris gasipaes).

In South-Eastern Nigeria, the most common of all these species for palm wine harvesting is the African Oil Palm (Elaeis guineensis), which also produces the palm oil used for cooking food, as well as the palm kernel used for making soap [6, 7, 9, 15].

The palm wine industry is a huge money-making venture in Eastern Nigeria as well as the middle-belt of Nigeria; because apart from the nutritious value and health benefits from this sweet syrup, it has enormous socio-cultural attachment with the people [16]. For example, it is impossible to seek the hand of a woman in marriage in Igbo culture without presenting the palm wine to the parents. Sometimes, the message of acceptance is conveyed through the acceptance of the palm wine. In the grand finale of the marital consultations, a small gourd of palm wine is given to the bride to go search for the groom in the midst of the boys, once the groom sips from the gourd, the deal is sealed, and the marriage ceremonies could be scheduled at agreed dates.

In fact, all marriage ceremonies, burial ceremonies, child-naming ceremonies, house warming, graduation and most socio-political events, usually have the palm wine.

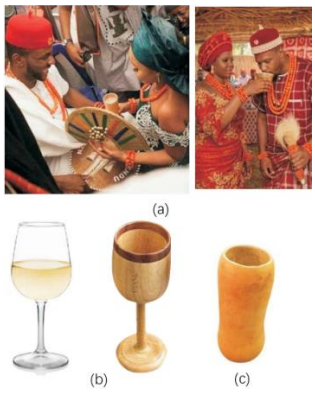

Figure 2. *(a) Igbo tribe marriage ceremony (b) palm wine glass (c) palm wine gourds.*

Across the southern Nigeria and the middle-belt where this palm wine elixir is deeply appreciated, the population is over 150 million. This makes the palm wine tapping a huge business that needs modernization through innovative technology.

Interestingly, the palm trees are littered in every community spanning from the Southern Nigeria to the middle-belt, making it a reliable raw material source, which makes the business certainly sustainable. And because wine tapping has historically remained lucrative but quiet, it is possible to see wine tappers in the Nkanu, Nsukka, Abakaliki or Umunneochi communities of South-Eastern Nigeria building mansions and sending their children to universities.

Figure 3. *Palm trees.*

This is the exact reason the palm wine tapping business needs some technological inroads to enable the farmers harvest the drinks with minimum stress and risk.

1.1. Types of Palm Wine Harvestable from the Oil Palm Tree (Elaeis Guineensis)

There are two types of palm wine harvestable from the oil palm tree which comes from two tapping methods.

They are:

1) *The Down-wine:* The Igbo tribe of the Eastern Nigeria call it "nkwu-ani". This is a palm wine sourced from felled trees. In this method, the palm tree is felled, and an incision is carved near the inflorescence, using as sharp knife, and a gallon or palm wine gourd affixed to the incision area, from where the sap exudes into the gallon.
2) *The Up-wine:* The Igbo tribe call it "nkwu-enu". The up-wine is tapped by climbing the living palm tree to reach its inflorescence (flowering area). An incision is also carved and subsequently treated with heat for preservation, as done in the down-wine method. The problem with this method is basically the fear of falling from such very tall palm trees, most of which project into the blue skies.

The difference between the two types may not be strikingly

clear, but experienced drinkers could tell from their tastes. Similarly, a few drinkers usually complain of hangover headache after sipping some fresh down-wine, whereas, many more prefer the up-wine; probably figfbecause it comes from a living tree. Nevertheless, both down and up wine are good, and are creating wealth and health for the people. Also, note that as sweet, milky and fresh as they are, they turn to alcohol after about 2 hours. But many who savor the drink, say after the 2 hours, begins the threshold of its richness, quality and uniqueness [2, 4, 8, 11, 12, 16].

Figure 4. *A man pouring palm wine into a cup.*

1.2. Palm Wine Harvesting and the Emerging Technology

Obviously, there has not been any meaningful research done in the area of palm wine harvesting, let alone introducing technology thereto. And because of this, the industry has not been able to attract much young people, especially college graduates who seek employment in alternative sectors. This is because the two methods of harvesting the palm wine, still pose heavy risks, and appear laborious. Nevertheless, whatever type of technology we intend to introduce must be economical. It must be easy to use, cheap, durable and common. This is to ensure that profits made from the trade are not lost into the technology.

In China, the same palm wine called (Lizhi jiu or Litch wine), tastes sour when compared to that of Nigeria; but it is interesting to see that in harvesting theirs, they either fell or climb the palm trees too. Nonetheless, in furtherance of the search to introduce technology thereto, the Chinese began to extract the sap directly from the palm tree trunks. In a somewhat similar approach, the North America Maple Syrup producers were encouraged to adopt new technology in palm sugar production, by drilling deep holes below the bark of palm trees in order to maximize sap flow [1, 3, 10, 17].

Figure 5. *Sap from maple tree.*

As time went on, sugar makers in Vermont began to use vacuum pumps which gave them high yield.

1.3. Focus on Tapping from Living Palm Trees

Palm wine from living palm trees are confirmed to be healthier, preferable, and sells faster in the Southern Nigeria Markets. Although there is yet to be a laboratory research to prove that saps from living trees are healthier than those from felled trees, but historical complaints from a few, suggest that palm wine harvested from felled trees often inflict minor hangover headache, which though fizzles out after a short while. This could be the reason the wine from living palm trees sell faster, This is what makes this innovative research to focus on the safe way to harvest palm wine from living trees without climbing them [2, 4, 8, 11, 12, 13, 16].

In view of the risk of falling to death from tall palm trees whose fronds wave into the blue skies as commonly seen in Eastern Nigeria, coupled with the fact that the palm wine business is highly lucrative, it is imperative to introduce a technology where wine tappers will no longer climb the trees, but stay at the foot of the palm trees to tap from the trunk. This is the only way the business will see the influx of young people with collegiate training.

2. Mechanism

For us to understand how to apply the needed technology where palm sap could be tapped from the trunk, we need to know how the sap moves and where it is stored in the palm tree.

Maple trees rely on freeze-and-thaw pressure changes to transport sap [1, 3]. They have a reservoir in the heartwood where sap is stored. But in the case of palm trees, there is a natural mechanism that pushes the sap upward from the root to the inflorescence region, by a constant natural root pressure. This is because palm trees do not store large sap reserves in

their heartwood. The flow of sap fully depends on the continuous upward movement of water and nutrients toward flower growth (inflorescence) [1, 2, 10, 17].

Therefore, as the sap naturally store at the inflorescence region of the palm tree, we need a technology to suck the sap down. According to Walters and Smith [14], vacuum applied at a tap helps to artificially reduce the external pressure, leading to an increased differential pressure.

Let me explain further in clear terms.

This means that we would need to apply a strong vacuum to boost extraction volumes. As the suction breaks surface tension, blockages at the cut-point are cleared. And this induces heavy sap flow downward. This induced flow is faster than the flow from natural gravity.

Figure 6. *Vacuum-tubing system.*

Although no machine can force a palm tree to create a sap reservoir within the heartwood, but applying a vacuum system (suction) to the freshly-tapped palm tree, can significantly lead to high sap yield. However, excellent flow depends on proper tapping at the palm tree trunk [1, 5].

3. Vacuum-tubing, Design and Experiment

Vacuum-tubing is the most effective technology to help draw down an array of palm sap moving upward the inflorescence of palm tree [14]. It involves the use of a vacuum pump which creates suction pressure. This suction pressure generates a pressure difference between the moving palm sap and the vacuum pump. The sap pressure is naturally higher than the vacuum pump, and because nature obeys movement from region of higher pressure to region of lower pressure, the sap movement becomes interrupted, and begins to flow into the vacuum container.

For effective downward flow of the palm juice in vacuum-tubing, an “L-shape” incision would be carved or drilled just below the bark of the tree trunk, using a hand-held drilling machine. This could be manual or powered by a generator.

The “L-Shape” incision is expected to have a dimension of about 3 inches vertical cut, and 3 inches deep horizontal penetration, which must be constricted. Nonetheless, let the drilled hole conform with the shape of the suction tap attached to the vacuum tube.

This technology uses three economy tools which every palm wine tapper, including the subsistent ones can afford. They are: (a) Manual drilling machine for drilling holes into the palm tree trunk. (b) a set of vacuum pump with its tube and tap. This has both manual and generator-based designs, and lastly (c) Suction tap.

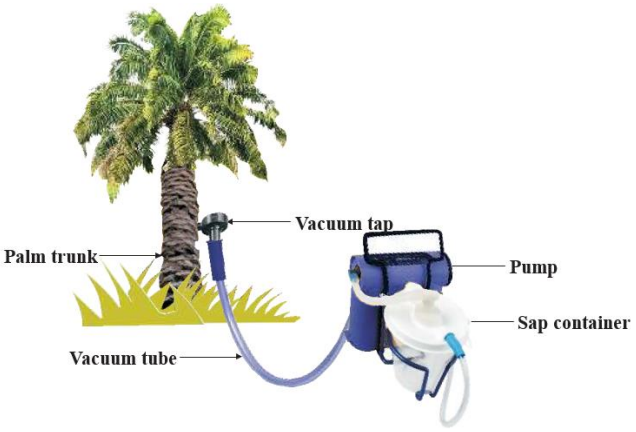

Figure 7. *Vacuum-tubing experiment.*

This fully agrees with Bernoulli's principle where pressure difference causes downward flow of fluid moving in vertical direction.

Therefore, in Bernoulli's effect, as the speed of the flowing palm sap increases, its internal pressure decreases. And being a fluid moving in vertical direction, it means that energy is constantly exchanged between the palm sap motion, its pressure and elevation. As earlier mentioned in this innovative research, fluids naturally flow from high pressure region to low-pressure region in order to sustain balance [1, 10, 14, 18].

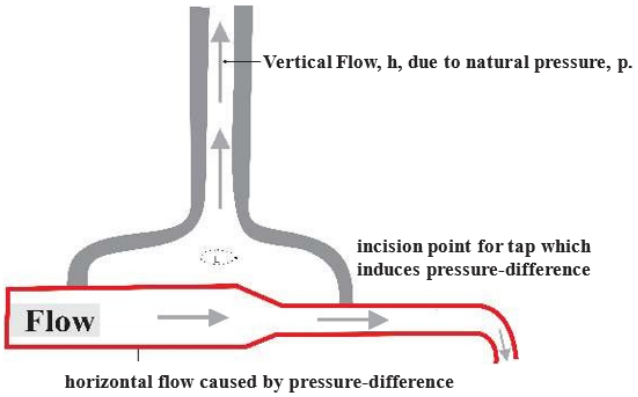

Figure 8. *L-shape incision for tap to cause horizontal flow via pressure difference.*

From the above, the relationship between the vertical movement, speed and pressure conforms with the Bernoulli's equation:

$$P + \frac{1}{2}\rho v2 + \rho gh = Constant \quad (1)$$

Where:
P = Static Pressure
ρ= Fluid Density
v = Fluid Velocity
g = Acceleration due to gravity
h = Vertical Elevation

In vertical flow, if the palm sap moves to a higher elevation, h increases while keeping the speed constant, its gravitational potential energy increases. To sustain a balance, the static pressure, p, of the palm sap must decrease.

Conversely, when the sap is forced to move downward, the potential energy decreases, thus, making the static pressure, p, of the sap to increase [5].

4. Conclusion

This research work experimented on the possibility of tapping palm wine while staying at the foot of a palm tree without climbing. A vacuum-tubing technology (VTT), which involved the use of a vacuum pump that created suction pressure, a simple drilling machine and a suction tap, were successfully deployed. This experiment proved that fresh palm wine could be tapped from a living palm tree using vacuum-tubing.

Abbreviations

VTT Vacuum-Tubing Technology

Author Contributions

Michael Okeke Obaji: Conceptualization, Formal Analysis, Methodology, Resources, Writing – original draft

Data Availability Statement

Data used in this article are available upon request to the corresponding author.

Conflicts of Interest

The author declares no conflicts of interest.

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Biography

Michael Okeke Obaji possesses a Doctorate Degree in Precision Instrumentation Engineering and Precision Machinery, majoring in intelligent mechanics & robotics, obtained from the Prestigious University of Science and Technology of China. He installed the four production lines that birthed the Ebonyi Pipes Production Ltd, Ezzamgbo, Ebonyi State Nigeria, where he was later appointed as the General Manager. Michael Okeke Obaji was a Lecturer at the Department of Mechatronics Engineering, Federal University, Oye-Ekiti, Nigeria. He also recently had a stint as a lead-researcher with the Intelligent Mechanics laboratory of the PIPM, University of Science & Technology of China. He is currently with the Department of Electrical & Electronic Engineering, Ebonyi State University, Abakaliki, Nigeria. He has contributed immensely in authoring some high quality journal papers indexed and presented at international conferences. His area of interest includes Artificial Intelligence and Bionic Robots.