

Exploring avocado pomace and briquettes as alternative fuel sources

This report was produced by Triple Line, based on research and data analysis conducted by Dr Simon Wagura Ndiritu, Associate Professor at Strathmore University Business School, and data from Origen Fresh.

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Challenges with firewood as a fuel source

Firewood remains a highly important energy source for small business across Africa, though it is not without its issues. **Burning firewood for fuel is highly polluting**, releasing 1,432 CO₂ parts per million (PPM) per 0.285kg of fuel. Existing research into biomass briquettes has found that the briquettes produce fewer (in some cases 50% less) CO₂ emissions compared with other fuel sources such as firewood and woodchips.¹ **Firewood is also found to be costly compared to biofuels**, particularly those produced from waste products from food production businesses.

The role of alternative fuels for small businesses in Africa

As the need to reduce CO₂ emissions increases in order to meet the Paris Agreement commitments of limiting global temperature rise to 1.5 degrees Celsius above pre-industrial levels, small businesses are seeking ways to minimise their environmental impact while not increasing costs of production. One of the ways in which small-scale food production enterprises are achieving this is through transitioning from traditional fuel sources to biofuels as a means of powering their production processes. In transitioning from firewood to biofuel, energy costs may be lower and companies may be able to reduce their CO₂ pollution.

Origen Fresh's business model and the incorporation of biofuels

Origen Fresh is an East Africa-based for-profit social enterprise producing quality natural oils, including avocado oils and other vegetable and essential oils. Origen Fresh sources its inputs, mostly fruits, vegetables and nuts, from local smallholder farmers, with a particular emphasis on building partnerships with female and youth farmers. One of the company's products is avocado oil, which they produce by extracting oil from the pulp of lower quality avocados bought from smallholder farmers. The production of this oil generates an avocado waste product, pomace, which can itself be used as a biofuel, or converted into avocado briquettes, another form of biofuel. Currently, it is the only avocado oil refinery operating in East Africa, with oil production factories in Kenya, Tanzania, Uganda and Ethiopia.

Pomace, the waste from the avocado oil production process is made using approximately 55% of the fruit. Avocado's moisture content is about 220% initially; then, once it is pressed with the belt press, the moisture content falls to 16% following processing in a rotary drum drier.² Once it has been dried and pressed, pomace can be used as a fuel source, though only in combination with another fuel such as firewood or briquettes. Avocado briquettes can be produced from the pomace. The pomace is mixed with ash or sawdust, shaped and sundried for 3-4 hours to form briquettes which can be used as a stand-alone fuel source. Origen Fresh uses energy to power its boilers used in the production of its vegetable and essential oils. Previously Origen Fresh has relied on firewood to power its production processes, but recently they have been experimenting with alternative fuel types, primarily to try to reduce their CO₂ emissions but also in the hope that it may help reduce fuel costs.

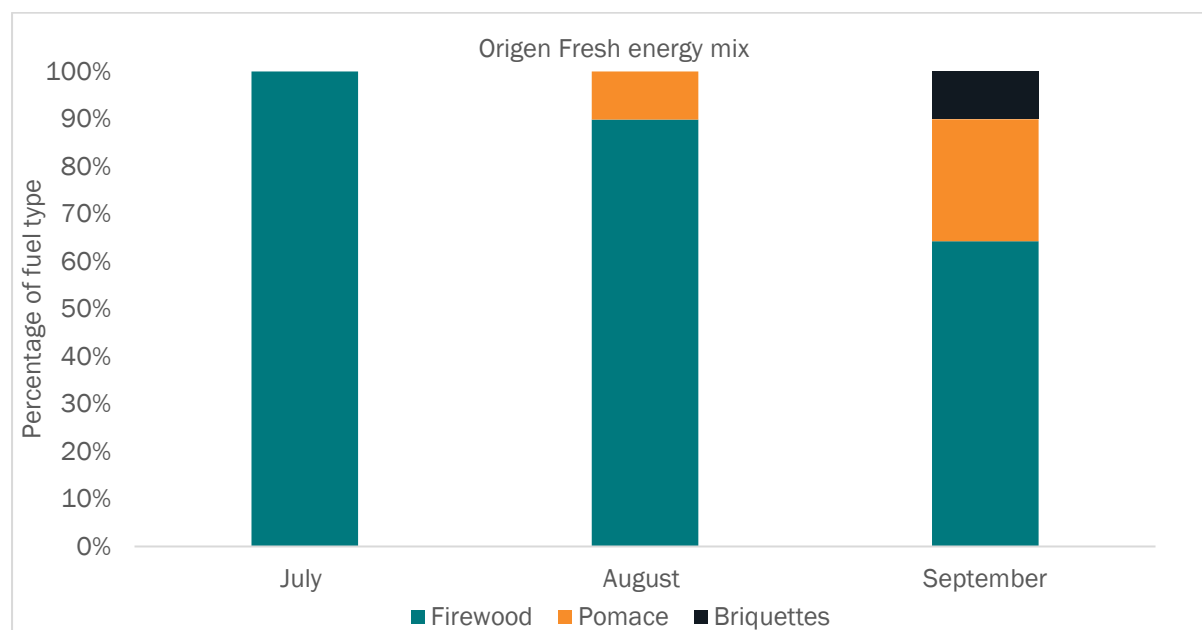
¹ Fanarraga Lukuy, D. C. et al. (2022) Production of Ecological Briquettes from Avocado Pit Waste as Biofuel. *Chemical Engineering Transactions*. 92, pp. 192-198.

² Origen Fresh ERP Data, 2022

Origen has found that, in transitioning to an avocado by-product dominated energy mix, they have reduced their production costs and their greenhouse gas emissions, addressing the challenges identified with firewood.

Figure 1 presents the change in Origen Fresh's energy mix over the period July to September 2022. The share of firewood has decreased from 100% (80,442 kgs) in July to 64% (42,955 kgs) in September, following the introduction of pomace into the energy mix in August and briquettes in September. In September, pomace and briquettes made up 36% (23,863 kgs) of Origen Fresh's fuel mix. Origen aims to completely replace firewood with avocado by-product fuel sources, eventually having an energy mix made up 100% of briquettes.

Figure 1: Origen's energy mix from July to September 2022

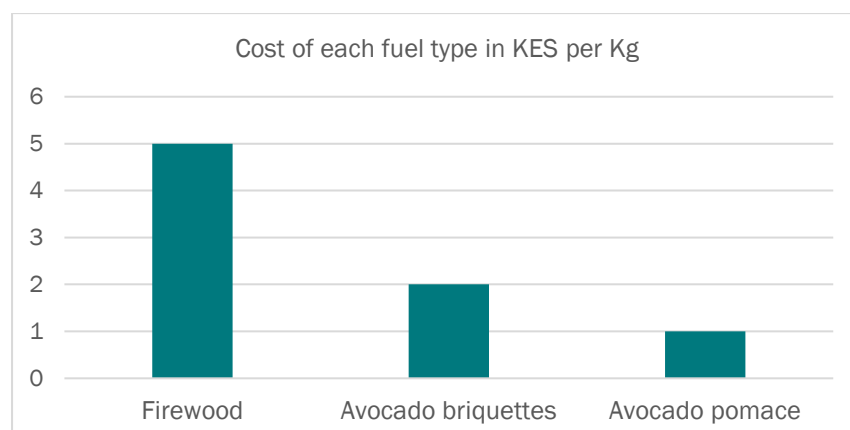


Benefits experienced by Origen of transitioning to biofuels

In transitioning to using avocado by-products as fuel, Origen has seen various benefits.

One of the advantages of switching to a fuel mix dominated by avocado waste products such as pomace and briquettes is the lower cost associated with use of avocado oil by-products. The cost of each of the fuel types is shown in Figure 2.

Figure 2: Cost of each fuel type in KES per kg (source: Origen Fresh ERP data, 2022)



Avocado pomace is a much cheaper fuel than firewood, given the limited processing necessary before it is ready for use (costing 1 Kenyan Shilling (KES) per kg). As expected, as the briquettes require additional material, such as ash and processing to produce so briquettes are slightly more expensive than pomace. **Firewood is the most expensive fuel type of the three, costing KES 5.** Data from Origen Fresh shows that, as the share of avocado waste used as a fuel in the energy mix increased, the average fuel usage per day decreased.

A further benefit to transitioning from firewood to avocado briquettes as a fuel source is that avocado briquettes produce fewer CO₂ emissions than firewood. Data collected on the respective CO₂ emissions can be found in **Table 1.**

Table 1: Relative CO₂ and heat emissions of each fuel type

Fuel type	CO ₂ (ppm x 0.285 kg of fuel)
Avocado briquettes/pomace	480
Firewood	1,432

Avocado briquettes and pomace both produce significantly less CO₂ than firewood when used as a fuel source, producing only 480 CO₂ parts per million (PPM) compared with 1,432 CO₂ PPM produced by firewood. As such, **avocado briquettes and pomace were found to be less polluting fuel sources than firewood.**

In addition to being less polluting, avocado briquettes were found to generate a more concentrated form of energy, providing greater heat efficiency than firewood, producing a relatively more intense heat.³ **Fewer briquettes are required to produce the same amount of heat as the equivalent quantity of firewood. Briquettes**, due to their compressed nature, serve as a longer-lasting fuel source than firewood and **are therefore a more efficient fuel type.**⁴ As previously mentioned, as the share of avocado waste used as a fuel in the energy mix increased, the average fuel usage per day decreased. This indicates that briquettes are a more fuel efficient energy source than firewood.

Before Origen began purchasing the avocados from their smallholder partners, no market existed for lower quality avocados and the avocados rejected from the export market were going to waste. In using the waste products in the avocado oil production process, and the waste products from that process as an energy source, **Origen is repurposing the avocado oil by-products and reducing the amount of waste sent to landfill.**

In transitioning away from using firewood as a fuel source to using biofuels produced from the by-product of the avocado oil production process, Origen Fresh has successfully reduced their production costs, carbon emissions, and the quantity of waste being sent to landfill, overcoming the issues they faced in using firewood. **Origen Fresh indicated that there were no downsides to replacing firewood with avocado waste products as the sole energy source.**

³ Benefits of briquettes & pellets over other fuels. (2020, February 26). Ecostan®. <https://www.ecostan.com/uses-of-briquettes-pellets#:~:text=They%20have%20a%20higher%20practical,their%20low%20moisture%20and%20density>

⁴ ibid