

How Nigeria can turn its huge cashew waste into valuable citric acid

June 29 2022, by Agbaje Lateef and Adeoye O. Adekunle (Ph.D.)



Cashew apples. Credit: Pixabay/CC0 Public Domain

Nigeria—[the sixth largest producer of cashew nuts globally](#)—exports more than 80% of its raw cashews primarily to [Vietnam and India](#) where they are processed into various consumer products such as butter, food

and cosmetic ingredients.

But Africa's most populous nation can extract more [economic value](#) out of cashews by using their wastes to produce [citric acid](#).

Cashew is [a tropical tree](#) cultivated for its fruit (cashew nut) and pseudofruit (cashew apple). The nut is the major reason for planting cashew—it is very nutritious. The fleshy "apple" part yields a juice which is high in vitamins and minerals.

But the juice is high in anti-nutrients too. These are compounds that prevent the body from absorbing nutrients. They also [make the juice less palatable](#). Because of this, cashew apples are mostly discarded.

The apple pulp, shell and liquid from the shell are all [wasted](#) or underutilized. Yet, these are valuable materials and they can be improved by biotechnology.

We've been conducting [work](#) into the [potential](#) of producing citric acid from cashew juice. It was the first effort globally to produce citric acid from cashew juice. Citric acid is widely used to preserve blood, drugs and processed foods and drinks. Its global value is expected to reach [US\\$4 billion in 2027](#).

We used cashew from [Ogbomoso](#), southwest Nigeria, an area that produces some of the best cashew nuts in Nigeria.

Cashews in Nigeria

Nigeria currently harvests [200,000 to 240,000 metric tons](#) of raw cashew nuts each year, with about 85% of this exported. Nigeria's no different to other African countries that export the bulk of their production as raw cashew nuts.

Africa, with production of 2,334,405 tons, is [the world's largest producer and exporter of raw cashew nuts](#), accounting for more than 50% of production. Between 2000 and 2018, [world trade](#) in raw cashew nuts [more than doubled to 2.1 million tons](#), and African producers—led by Côte d'Ivoire—accounted for almost two-thirds of the growth. In 2020, [trade in cashew nuts was worth US\\$6.87 billion](#).

Cashew farming [contributes](#) about N24 billion (about US\$58 million) to the Nigerian economy annually. It employs more than [600,000 people](#).

The sector could do more. Our work shows that citric acid can be produced from cashew apple juice, which is abundant in Nigeria. Domestic production would save Nigeria [US\\$31 million](#) a year in foreign exchange, based on citric acid imports for 2020.

Nigeria can produce citric acid from cashew apple juice by using [biotechnology](#)—the science of using [biological processes](#) to produce valuable materials and services. For instance, man makes use of some bacteria to convert milk to yogurt. Yeast is used in producing bread via biotechnology. Biotechnological products were [valued](#) at US\$752.88 billion in 2020 with projected growth of 15.83% for 2021–2028.

Cashew wastes, too, can be turned to [wealth](#) by creating new products. For instance, cashew nut shell liquid [produces](#) chemicals that can be used in the making of paints, varnishes, agrochemicals and medicines. Shell and pulp are [used](#) through biotechnology to produce animal feeds and bioethanol. Biotechnology can also turn the juice into [drinks and ethanol](#).

Citric acid from cashew

In our efforts to add value to cashew, we focused on the underutilized cashew apple juice and aimed to test the possibility of producing citric acid from the juice.

The demand for citric acid is growing because of [its usefulness](#) in food, pharmaceutical and cosmetic industries. New sources of nutrients are [needed](#) to grow [microorganisms](#) that produce citric acid.

Nutrients in the cashew juice and pulp [support the growth](#) of microorganisms.

We used [cashew apple juice](#) to grow black mold to produce citric acid for the first time globally. Black mold is a fungus that is widely distributed in the environment. It produces black spores when it grows. It is scientifically known as *Aspergillus niger*.

The mold grows on simple and cheap materials. It has been used [to produce citric acid](#) since 1919. It is used to produce different products, including enzymes, proteins and animal feeds. It is [celebrated](#) as a microorganism that has made huge contributions to biotechnology for 100 years.

The best locally sourced black mold consumed the juice to produce citric acid in large quantities. It produced 92.8g of citric acid per liter of juice after 10 days of growth. The yield is considered very high compared to those that were earlier [reported](#).

We used the citric acid to coagulate [soy milk](#) to make cheese. [Citric acid](#) is used as coagulant in producing cheese. We asked a panel to test the quality of the cheese. They found the soy cheese to have better characteristics than those produced locally using fermented liquor of corn. These include better color, texture, flavor and firmness.

We then used [scientific techniques](#) to increase the citric acid production. We manipulated growth conditions of the mold and applied nanomaterials in its nutrition in this regard. It was the first report globally to increase citric acid production by applying nanotechnology.

At various times, we used four techniques to improve capability of the mold. These include obtaining high-yielding mold by exposure to radiation. Then, we added sugar to the juice to study its effect on yield of citric acid. We evaluated the addition of zinc oxide nanoparticles on citric acid production. Finally, we determined the best growth conditions to support citric acid production by our mold.

These efforts increased citric acid production by the mold in cashew juice by about 2.38 to 11.98 times of the original production. For instance, addition of zinc oxide nanoparticles gave yield of 34.62% citric acid per day. The best growth conditions turned in 92.61% citric acid per day. These results showed that we can improve productivity of the mold to enhance commercial production of citric acid.

Moving forward

Large scale production of citric acid using cashew apple [juice](#) could achieve several benefits. It could:

- add value to cashew farming and increase income from planting the crop
- reduce the environmental nuisance of disposal of cashew apple
- enhance Nigeria's potential to produce citric [acid](#) locally
- boost the economy and save foreign exchange reserves.

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