BRIEFING NOTE

May 2024

MEDICINAL AND ECONOMIC POTENTIAL OF CITRUS WASTE

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KEY FINDINGS

Significant Findings: citrus fruits and citrus wastes (leaves) were collected from Greenwood Citrus farm, Fort Beaufort and Naudehoek farm, Peddie in the Eastern Cape, and Mystic Citrus Farm Eshowe, KwaZulu-Natal. The peel waste was obtained from the fruits. Both wastes were extracted from their essential oil compositions. The peels and leaves were dried and also ground into powder. The essential oils and the grounded powder were used for the insecticidal bioassay against maize weevils. The *Citrus limon* powder waste was the most effective compared to the other citrus waste. Nano films were synthesized from the leaves and peels of some citrus waste for maize farmers to use out of the citrus season. The citrus nanofilms were to be very effective as fumigation and also reusable. The nutritional evaluation of the treated and untreated maize was conducted along with consumer acceptability. Citrus fruits from Greenwood and Naudehoek were also evaluated for their possible use in animal feeds.

INTRODUCTION

Citrus fruit is one of the most important fruit crops in the world, with a global production of approximately 102 million tons yearly. It is well known for its dietary, medicinal, and agricultural benefits, to mention a few, because of its valuable source of bioactive compounds. Unfortunately, the citrus farms and industrial processing of citrus fruits leaves a huge burden of bioaccumulated wastes, as citrus by-products (peels and leaves) have been reported to account for one-fifth of the total industrial wastes generated globally, which translates to about 120 million tons of citrus-generated wastes annually. Thus, many of these waste products are released into the environment, causing serious environmental hazards.

South Africa is 7th major producer of citrus and the 2nd exporter of citrus oranges. According to the South African Citrus Growers Association (CGA), Limpopo (40%), Eastern Cape (25%), Western Cape (19%), and Mpumalanga (8%) have the largest production areas for citrus in South Africa. The Eastern Cape is the largest citrus-producing province and with the widest varieties due to its climate. An average of 1.6 million tons of citrus fruit are produced in South Africa on an annual basis. However, from the report gathered, during the processing of citrus (oranges) into juice, there is ~50% of the total weight of the orange is discarded as waste, which includes pulp and peel. Furthermore, during the juicing process, a sum of 1.5ml waste is produced per ton of fruit and contains ~15% soluble solids and 30% pulp. In addition, tons of the leaves are prune during the fruiting season to give good yield. The latter is off left to waste on the farm with its medicinal potential.

METHODOLOGY

The aim of this study was to determine the essential oils of the various citrus growing in two provinces, investigate the insecticidal potential of the essential oils, dry powder peel and leaf, and evaluate the nutritional and consumer acceptability of the treated maize. The essential oils were extracted using the hydrodistillation method and analyzed using GC and GCMS for chemical profiles. Known contact toxicity, repellency and fumigation bioassay methods prescribed in literature were used to assay the insecticidal potential. Elemental analysis, protein content, ash content, moisture content were test carried out for the nutritional analysis on the treated and untreated maize.

Biosynthesis of ZnO NPs was performed following the method described by Dejen et al., on the most active citrus waste species from the bioassay experiment; Nova mandarin (*C. reticulata*), Satsuma mandarin (*C. unshiu*) and Eureka lemon (*C. limon*).

MAIN RESULTS

A total of 10 species of citrus namely Nova mandarin (*C. reticulata*), Midknight and Cara cara oranges (C. sinensis L. Osbeck), Delta sweet orange (C. sinensis), Nules clementine (*C. clementina* and *Citrus clementine hort ex*. Tanaka), Satsuma and Orri mandarin (*C. unshiu*), and Lison and Eureka lemon (*C. limon*) were collected from both farms in the Eastern Cape while, Nova mandarin and Eureka were collected from the KawZulu-Natal. There were no significant differences in the essential oil composition between the two provinces. Only the percentage yield was higher for the Eastern Cape species. A total of forty-three to eighty-eight compounds, accounting for 91.5% to 99.6%, respectively, were identified in fresh and dried leaf citrus essential oils. The main compounds in leaf and peel essential oil were sabinene (20.4 - 32.4%) and terpinene-4-ol (13.2-18.6%) for the mandarins, while limonene (71.5-80.6%) and sabinene (10.7-15.0%) were the major compound identified in oils of three types of oranges investigated. D-limonene was the major component found in the Lison and Eureka lemon fresh and dry leaves and peels (29.5-75.1%). Also prominent were β-pinene, γ-terpinene, and geranial.

The result of the nutritional analysis shows that citrus enriches or increases the nutritional composition of maize, as it was found that the ash content of both leaf-treated maize and peel-treated maize was 1.67% and 1.57% respectively and higher than untreated maize, which was1.56%, literatures have stated that high ash content is in correspondence with many minerals in food. It was also found that citrus waste improved the shelf life of the maize, moisture content of leaf-treated maize and peel-treated maize (10.5% and 10.52% respectively) while, the untreated maize was 10.58%, food with high moisture content can speed up microbial growth, which could shorten the product's shelf life as well as cause it to degrade before it even reaches the shelves. The conducted elemental analysis proved that citrus really improves the mineral composition of maize; calcium on leaf and peel-treated maize was found to be 0.010% while untreated maize was 0.005%, Potassium was found to be higher in peel-treated maize and was 0.190% while both leaf treated maize and untreated maize was 0.180%.

The citrus nanofilm synthesized was found to be effective in killing the weevils within two hours and preventing any weevils from coming near the maize (fumigation potential) for more than 3 months.

Evaluation of the whole spoiled/rotten fruits for animal feeds substantial quantities of nutritional components such as protein, lipids, and fiber, among others, but *C. clementina* had a significantly higher protein content when compared to *C. limon* fruit. In addition, both the whole *C. limon* and *C. clementina* fruits contain significant dietary macro and micro elements such as Mg, Ca, Na, K, P, Cu, Zn, Fe, and Mn and may, therefore, be considered a rich naturally available ingredient source for livestock feeding based on the revealed presence of nutritional components of the plant.

Acknowledgments: The authors acknowledge the Department of Science and Innovation funding under the Waste RDI Roadmap.

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This Briefing Note is produced as part of the Waste RDI Roadmap Briefing Note Series,
an initiative of the Department of Science and Innovation managed by the CSIR.
The Note stems from the findings of a grant project funded under the Roadmap, entitled
"*Reactor design for industrial furfural production from sugar cane agricultural residues*".