Value-adding potential of pomegranate fruit peel: a cosmeceutical prospective

Olaniyi Amos Fawole

olaniyi@sun.ac.za
Twitter:@fawwyb

Expertise: Postharvest Technology and Value –addition of Horticultural Produce
Stellenbosch University
South African

What do I do?

- ✓ Ensure delivery of optimal quality and safe agricultural product for consumer acceptance and also reduce postharvest losses

How do I achieve?

- ✓ I focus on maintenance of produce quality and enhancement of storage life throughout the value chain - harvesting, handling, packaging, storage and distribution

The bigger picture

- ✓ Food and nutrition security
- ✓ Maximize profit for stakeholders
- ✓ Conservation of natural resources

Pomegranate fruit

- ✓ Deciduous shrub (short tree)
- ✓ Over 1000 cultivars have been identified globally
- ✓ The peel colour – yellow, green or pink overlaid with pink to deep red to fully red or deep purple depending on cultivar





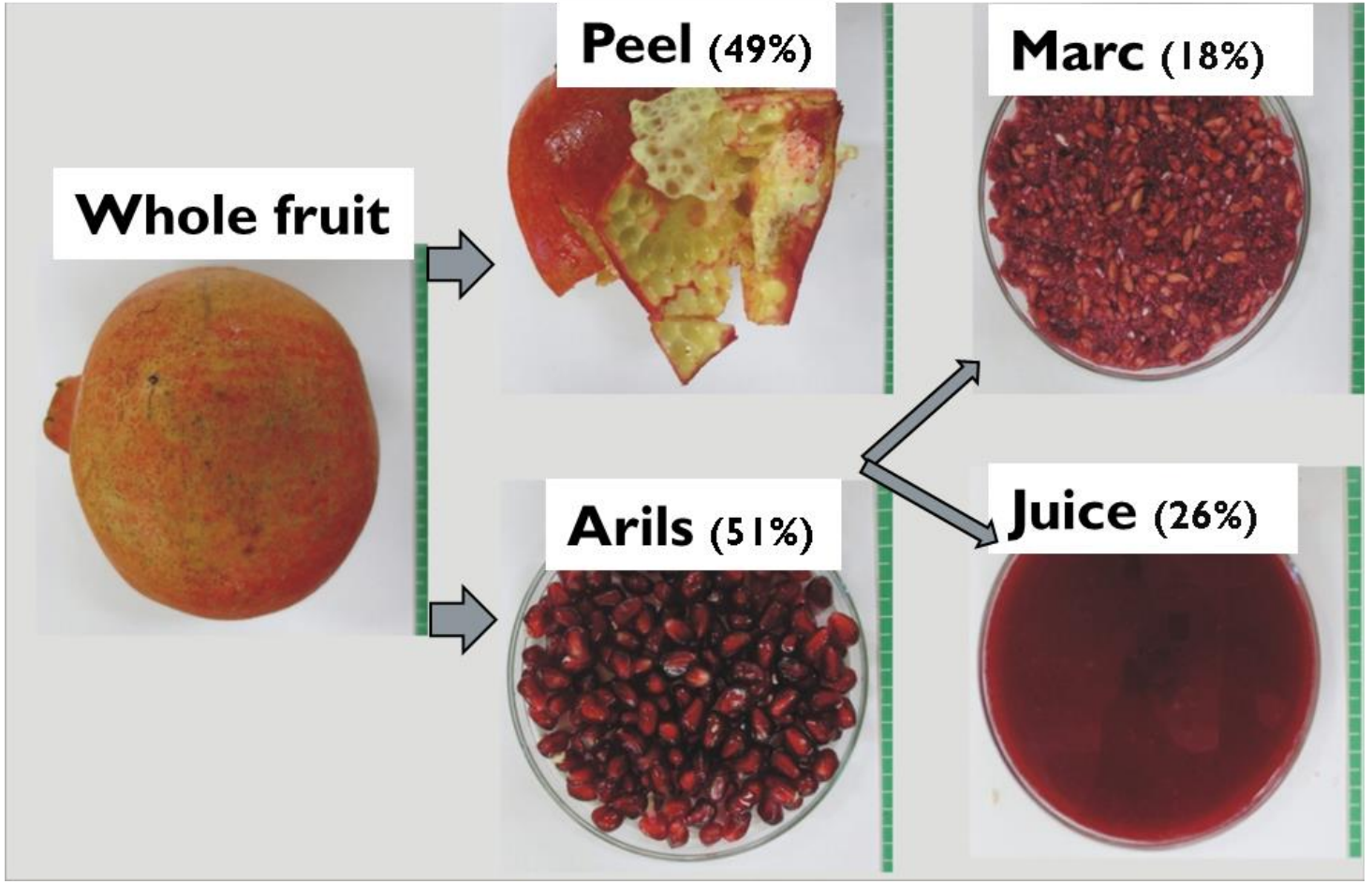

Pomegranate – a high value crop

✓Reported potential health benefits:

- ❖ Antioxidant, anti-mutagenicity, anti-diabetic anti-microbial, anti-hypertension, fertility, sperm count and mobility
- ❖Over 122 bioactive compounds identified in pomegranate

Seeram et al., 2006; Lansky and Newman, 2007

Edible vs. non-edible



Fawole et al., 2016.

<u>Pomegranate Industries</u>
Fresh fruit
Fresh arils
Juice

Wastes

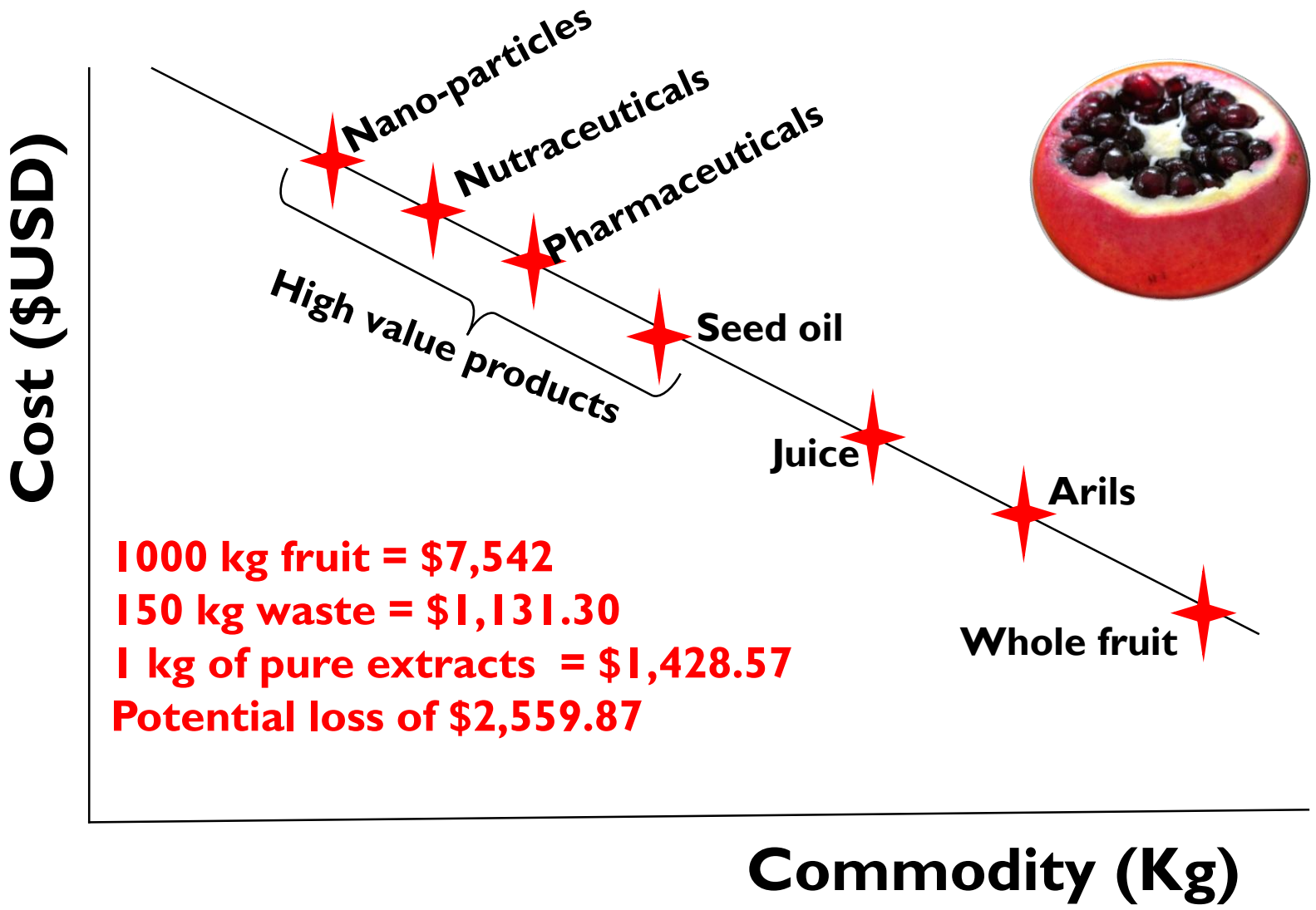
- Fruit processing
- Disposal of cracked or sunburned fruits

Waste disposal constitutes environmental problems

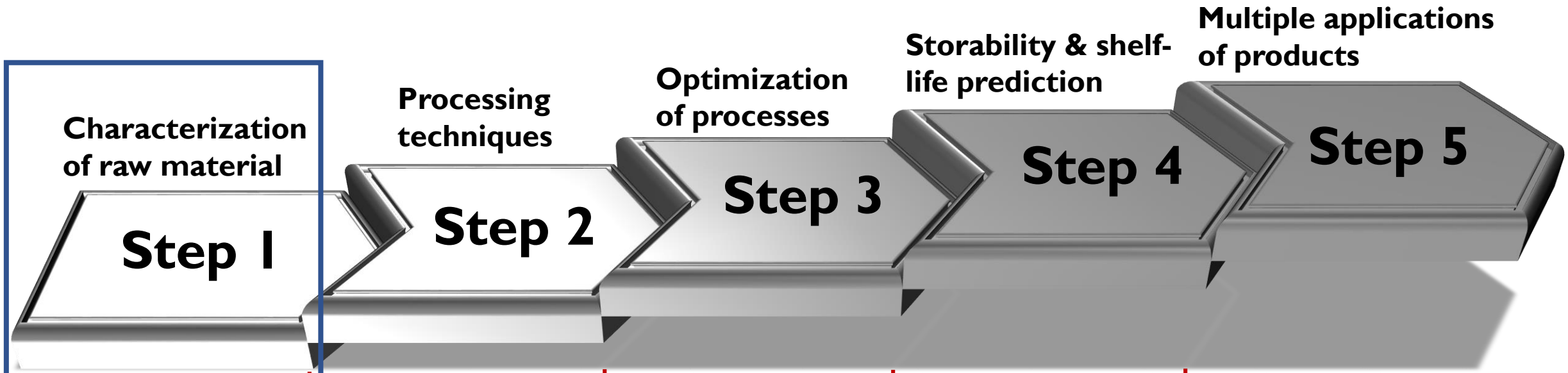
Commercial pomegranate products

- All in the South African markets
- Consumer driven – booming
- All imported products – none made South Africa, nada!
- Yet, S. Africa is a major supplier of pomegranate in the S. Hemisphere

Value addition



Exploring value adding potentials of pomegranate fruit



Properties based on;
- Cultivars
- Fruit parts
- Storage duration of raw material
- Safety/Toxicity

- Pre-treatments
- Drying methods
- Extraction method

- Environmental friendliness
- Cost
- Yield of processed materials

- Effect of storage conditions and packaging material
- Encapsulation and capsulation of pure products

- Food industry & bakery
- Beverage industry
- Beauty industry
- Nutraceuticals
- Postharvest treatments (wax formulation)
- Active packaging

Exploring value adding potentials of pomegranate fruit

Objective:

To investigate cosmeceutical- important biological activities of pomegranate peel

Specific objectives:

- **Investigate the antibacterial, antioxidant and tyrosinase enzyme inhibition**
- **Quantification of phytochemicals**

Materials and methods

Seven cultivars

"Arakta, Bhagwa, Ganesh, Herskawitz, Molla de Elche, Ruby and Wonderful"

Sample preparation

Freeze- dried, milled and extracted in 80% methanol or water (1:5; w:v)

Antibacterial assay: Microdilution antibacterial assay

Gram-negative bacteria (*Escherichia coli* ATCC 11775 and *Klebsiella pneumonia* ATCC 13883)

Gram-positive bacteria (*Bacillus subtilis* ATCC 6051 and *Staphylococcus aureus* ATCC 12600)

Antioxidant assays

Radical-scavenging ability

Ferrous ion chelating (FIC) assay

Ferric ion reducing antioxidant power (FRAP) assay

Anti-tyrosinase assay

L-3,4-dihydroxyphenylalanine (L-DOPA, Sigma) and tyrosine as substrates

Momtaz et al. , 2008; Fawole et al., 2012

Table 1 Antibacterial activity of fruit peel methanol extracts of pomegranate cultivars cultivated in South Africa

Cultivar	Extract	Minimum inhibitory concentration (MIC; mg/ml)				TAI
		B.s	E.c	K.p	S.a	
Arakta	MeOH	0.39^{b}	0.78^{b}	0.20^{a}	0.39^{b}	6.00^{b}
	Aqueous	>12.50	>12.50	>12.50	>12.50	<1.00
Bhagwa	MeOH	0.39^{b}	0.78^{b}	0.20^{a}	0.78^{c}	5.70^{a}
	Aqueous	>12.50	>12.50	>12.50	>12.50	<1.00
Ganesh	MeOH	0.39^{b}	0.39^{a}	0.20^{a}	0.78^{c}	6.00^{b}
	Aqueous	>12.50	>12.50	>12.50	>12.50	<1.00
Herskawitz	MeOH	0.20^{a}	0.39^{a}	0.20^{a}	0.78^{c}	6.25^{c}
	Aqueous	>12.50	>12.50	>12.50	>12.50	<1.00
Molla de Elche	MeOH	0.39^{b}	0.78^{b}	0.39^{b}	0.26^{a}	5.92^{ab}
	Aqueous	>12.50	>12.50	>12.50	>12.50	<1.00
Ruby	MeOH	0.39^{b}	0.39^{a}	0.39^{b}	0.39^{b}	6.00^{b}
	Aqueous	>12.50	>12.50	>12.50	>12.50	<1.00
Wonderful	MeOH	0.39^{b}	0.59^{ab}	0.33^{b}	0.39^{b}	5.99^{b}
	Aqueous	>12.50	>12.50	>12.50	>12.50	<1.00
Streptomycin (µg/ml)		3.13	3.13	2.60	5.21	

Mean values in the same column followed by different letters (a-c) represent statistical different ($P < 0.05$) using the Duncan's multiple range test. *MIC*- Minimum inhibitory concentration, *TAI* – Total antibacterial index, the higher the TAI the higher antibacterial activity.

Table 2 Antioxidant activity of fruit peel methanol extracts of seven pomegranate cultivars cultivated in South Africa

	DPPH (%)			FIC (%)			FRAP (abs. at 593 nm)		
Cultivar	**1000 µg/ml**	**100 µg/ml**	**10 µg/ml**	**1000 µg/ml**	**100 µg/ml**	**10 µg/ml**	**1000 µg/ml**	**100 µg/ml**	**10 µg/ml**
Arakta	83.54 ± 0.31^{d}	13.35 ± 0.98^{ab}	5.55 ± 0.06^{c}	79.44 ± 0.21^{a}	49.94 ± 0.89^{a}	37.32 ± 1.82^{b}	1.19 ± 0.03^{ns}	0.52 ± 0.02^{b}	0.11 ± 0.00^{c}
Bhagwa	73.02 ± 0.26^{ab}	12.34 ± 0.73^{ab}	1.37 ± 0.34^{a}	84.96 ± 1.43^{bc}	65.54 ± 1.09^{c}	18.83 ± 0.22^{a}	1.03 ± 0.28	0.38 ± 0.00^{ab}	0.04 ± 0.01^{a}
Ganesh	83.56 ± 0.05^{d}	16.70 ± 0.83^{bc}	2.42 ± 0.99^{ab}	82.98 ± 0.18^{b}	65.82 ± 0.51^{c}	15.80 ± 0.52^{a}	1.47 ± 0.04	0.73 ± 0.12^{c}	0.08 ± 0.01^{bc}
Herskawitz	78.06 ± 0.71^{c}	15.18 ± 0.97^{abc}	2.71 ± 0.77^{ab}	87.82 ± 0.57^{de}	69.97 ± 0.25^{d}	34.32 ± 2.45^{b}	1.29 ± 0.04	0.34 ± 0.01^{ab}	0.08 ± 0.02^{bc}
Molla de Elche	71.65 ± 0.08^{a}	10.59 ± 0.18^{a}	1.61 ± 0.08^{a}	86.59 ± 0.90^{cd}	70.57 ± 0.43^{d}	47.24 ± 1.34^{c}	1.47 ± 0.11	0.33 ± 0.05^{a}	0.03 ± 0.00^{a}
Ruby	83.34 ± 0.51^{d}	19.67 ± 2.24^{c}	4.10 ± 2.24^{bc}	83.58 ± 0.62^{b}	53.39 ± 1.29^{b}	47.25 ± 0.66^{c}	1.18 ± 0.02	0.38 ± 0.00^{ab}	0.08 ± 0.01^{bc}
Wonderful	74.19 ± 1.05^{b}	12.22 ± 3.13^{ab}	3.01 ± 0.47^{ab}	89.67 ± 0.72^{e}	71.02 ± 0.38^{d}	49.65 ± 1.26^{c}	1.32 ± 0.16	0.33 ± 0.01^{a}	0.06 ± 0.00^{ab}
Ascorbic acid	67.02 ± 0.06			62.15 ± 0.98					
Trolox									0.82 ± 0.03

Means in the same column followed by different letters (a-e) represent statistical significance ($P < 0.05$) according to the Duncan's multiple range test. Positive controls: Ascorbic acid and trolox.

Table 3 Effective inhibition concentration (EC_{50}) of fruit peel methanol extracts against tyrosinase

Cultivar	IC_{50} Monophenolase (μg/ml)	IC_{50} Diphenolase (μg/ml)
Arakta	11.03 ± 0.08^{c}	15.88 ± 0.10^{a}
Bhagwa	3.66 ± 0.11^{a}	21.16 ± 0.09^{a}
Ganesh	25.38 ± 0.06^{f}	40.93 ± 0.12^{b}
Herskawitz	7.56 ± 0.08^{b}	59.03 ± 0.07^{c}
Molla de Elche	25.56 ± 0.06^{f}	27.11 ± 0.09^{ab}
Ruby	20.33 ± 0.07^{d}	114.9 ± 0.08^{e}
Wonderful	23.67 ± 0.06^{e}	27.26 ± 0.07^{ab}
Arbutin	34.66 ± 0.05^{g}	98.66 ± 0.12^{d}

Mean values in the same column followed by different letters (a-f) represent statistical different ($P < 0.05$) using the Duncan's multiple range test.

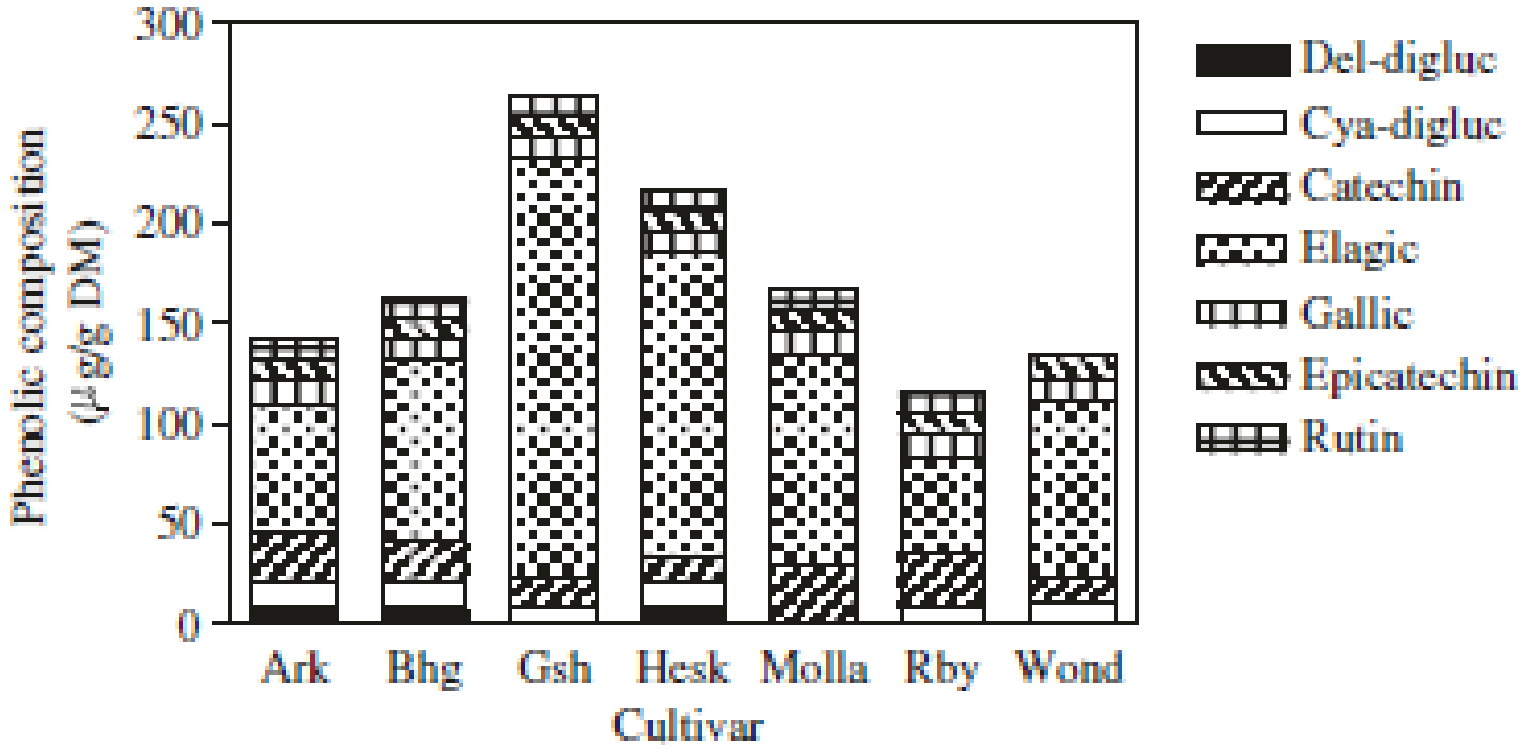
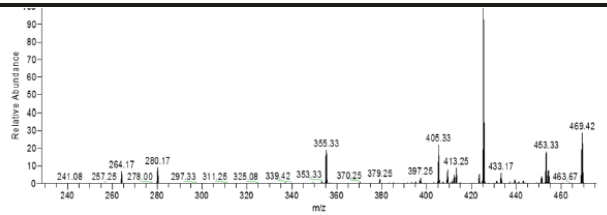


Figure 3 Phenolics composition in peel methanol extracts of seven pomegranate cultivars. Ark- *Arakta*, Bhg- *Bhagwa*, Gsh- *Ganesh*, Hesk- *Herskawitz*, Molla- *Molla de Elche*, Rby- *Ruby* & Wond- *Wonderful*.



Ganesh > Herskawitz > Molla de Elche > Bhagwa > Arakta > Wonderful> Ruby

Catechin, epicatechin, ellagic acid and gallic acid were found in all cultivars, of which ellagic acid was the most abundant comprising of more than 50% of total phenolic compounds detected in each cultivar

Conclusions

- Peel of the pomegranate fruit cultivars possess strong antibacterial, antioxidant and anti-tyrosinase activities

- Therefore the peel of the pomegranate fruit cultivars, instead of being wasted, could be exploited as a potential source of natural antimicrobial and antioxidant agents, as well as a potential tyrosinase inhibitor

- The findings provide scientific basis to promote value-adding of pomegranate fruit peels for cosmetic purposes

- Further studies on the isolation of active ingredients, determination of cytotoxicity and genotoxicity effects are warranted.

Fawole *et al. BMC Complementary and Alternative Medicine* 2012, **12**:200
http://www.biomedcentral.com/1472-6882/12/200

olaniyi@sun.ac.za
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