Wattle seed: Australia's ancient superfood

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Wattle seed (WS) is a hard coated seed grown within pods on wattle trees (*Acacia ssp.*) (Figure 1). There are approximately 1,350 species of wattles worldwide with more than 1,000 species native to Australia. They are Australia's most abundant tree and occur in all climatic zones and soil types.[1] Wattles were important to our Indigenous peoples for shelters, tools, habitat and food sources. There were more than 100 species of WS used for food.[2] WS was wild harvested as near ripe seeds, steamed and consumed, or ripe seeds processed and made into flour and flat bread.[3]

This traditional knowledge and use of Australian WS for human food led to introductions of various wattle species to Africa (Sahelian zone and arid zones of Ethiopia) in the 1980- 90's. Following extensive field evaluations and food safety trials, the seed of *A. colei* (Coles wattle) was registered as a tasty nutritious human food. When blended (25%) with cereals there were significant improvements (especially protein) in village diets in Niger.[4]

The Australian WS industry began in the 1980's based mainly on the wild harvest of *A. victoriae* (Elegant wattle) which was widespread and easy to harvest and process. The WS was roasted and ground, then used as a flavouring or spice. It has a unique flavour profile and aroma of roasted coffee beans, sweet spices, raisin and chocolate with a nuttiness and slight bitterness. Flavour profiles however vary greatly between species.

Recent industry surveys show that wild harvesters and growers produce approximately 18.5 tonnes of raw WS per annum (15 tonnes wild harvest, 3.5 tonnes from growers)[5] (Figure 2). There has, however, been significant wattle orchard expansion in south-eastern Australia from 2019 as the industry moves from a wild harvest base to horticultural production for consistent seed quality and supply (Figure 3).

The range of Wattle ssp. under development and domestication for temperate zones include: *A. longifolia*

Table 1: Comparison of nutritional profile of wattle seed and other legumes.

Nutrients	Wattle seed	Chick-pea	Cow-pea	Lentil	Green pea	Ref.
Crude protein (g/100 g)	18 – 33	24	25	26	25	(12,14)
Crude fat (g/100 g)	3 – 19	5	5	3	2	(12,14)
Dietary fibre (g/100 g)	29 – 41	NS	26	30	NS	(12,15)
Potassium (mg/100 g)	730 – 905	1155	1280	874	1021	(12,14)
Calcium (mg/100 g)	230 – 430	197	176	120	110	(12,14)
Iron (mg/100 g)	5 – 20	3	3	3	2	(12,14)

NS=not stated..

ssp. longifolia, A. pycnantha, A. retinodes, A. baileyana and *A. saligna*. In arid and semi-arid zones, they include: *A. victoriae, A. microbotrya, A. hakeoides, A. brachybotrya, A. argyrophylla* and *A. calamifolia*.

WS is fast becoming a versatile food and is generally roasted and ground into a flour or meal, then used as an additive or blend in foods. A range of food products and uses are shown in Figure 4.

Heavy roasted meal is used as a flavouring in desserts, savoury dishes, baked goods and beverages including coffee substitutes and blends. Extracts can also be added to flavour many food products. Light roasted meal retains the valuable nutrient profile and is used in health foods, protein supplements, breads and muesli, and could be used in organic superfood blends. Raw seed has been used for sprouting, malting and popping type WSs are under development.

Figure 1. Wattle seed - A. pycnantha (Golden wattle).

Figure 2. Wattle seed pods (A. pycnantha) ready for seed harvest.

Figure 3. Wattle tree orchard (A. baileyana - Cootamundra wattle) at seed harvest in South West Victoria.

Nutritional and health benefits of dietary wattle seed

Generally, WS is a good source of protein, dietary fibre, potassium, calcium, and iron. The nutrient levels vary between species. For example, the protein content in WS range from 18% in *A. victoriae* to 33% in *A. saligna*,[6] and this falls within the range of other legumes (Table 1). Protein quality of WS, in terms of essential amino acids (lysine and arginine), is comparable to soybean.[7] High amounts of arginine may improve cardiovascular health.[8] A mix of WS flour with cereal (wheat, millet and sorghum) gives a full and balanced essential amino acid profile.[9]

WS possess low glycaemic index and therefore could be a suitable ingredient in diabetic and other specialty diets.[10] Moreover, the dietary fibre in WS, particularly in *A. coriacea*, are higher than most legumes (Table 1). Dietary fibre in human foods may positively impact the health of the gut.[11] Wattle seed flours are currently being used as functional ingredients in bakery products, such as WS bread rolls, to increase the dietary fibre and protein content of the product and thus enhance its health benefits.

The fat in most WS species contains more polyunsaturated fatty acids (PUFA) than saturated fatty acid.[6] Linoleic acid is the predominant PUFA in WS, and accounts for about 34% of total fat in *A. cowleana* seed.[12] Linoleic acid can play a vital role in reducing blood cholesterol levels.[13]

Therefore, the high PUFA in WS could make composite WS flour a suitable healthy food for human consumption.

Potassium is the most abundant mineral in WS. Moreover, one of the challenges for including more plant-based protein in human diets is the risk of anaemia due to a lack of iron. Previous studies have shown that iron levels (5.0 – 20 mg/100 g) in WS[12] were higher than other legumes (Table 1). Therefore, addition of WS seed in food products may help attain the recommended dietary intake of iron (7mg/day for men and 12-16mg/day for women during pregnancy) required for alleviating iron deficiency anaemia.

Bioactive compounds

In addition to the high nutritional value of WS, extracts from the seed, such as *A. victoriae*, have an abundance of succinic acid and gallic acid.[16] These compounds are known to have strong antioxidant capacity and thus, WS extracts could be a good functional food ingredient.[17] Furthermore, oil extracted from *A. cyanophylla* seed has high amounts of bioactive lipophilic compounds, such as tocopherols and phytosterols, and are comparable to other popular oil seeds such as olive and peanut oil.[18] These bioactive compounds are known to provide human health benefits.[6]

Anti-nutrients and processing

Raw WS are usually processed prior to consumption due to the presence of anti-nutrients such as trypsin inhibitors and phytic acid. In addition, WS contains Djenkolic acid, a toxic compound which may cause formation of kidney stones over prolonged exposure.[19] However, the levels of anti-nutrients and toxic compounds varies between species.

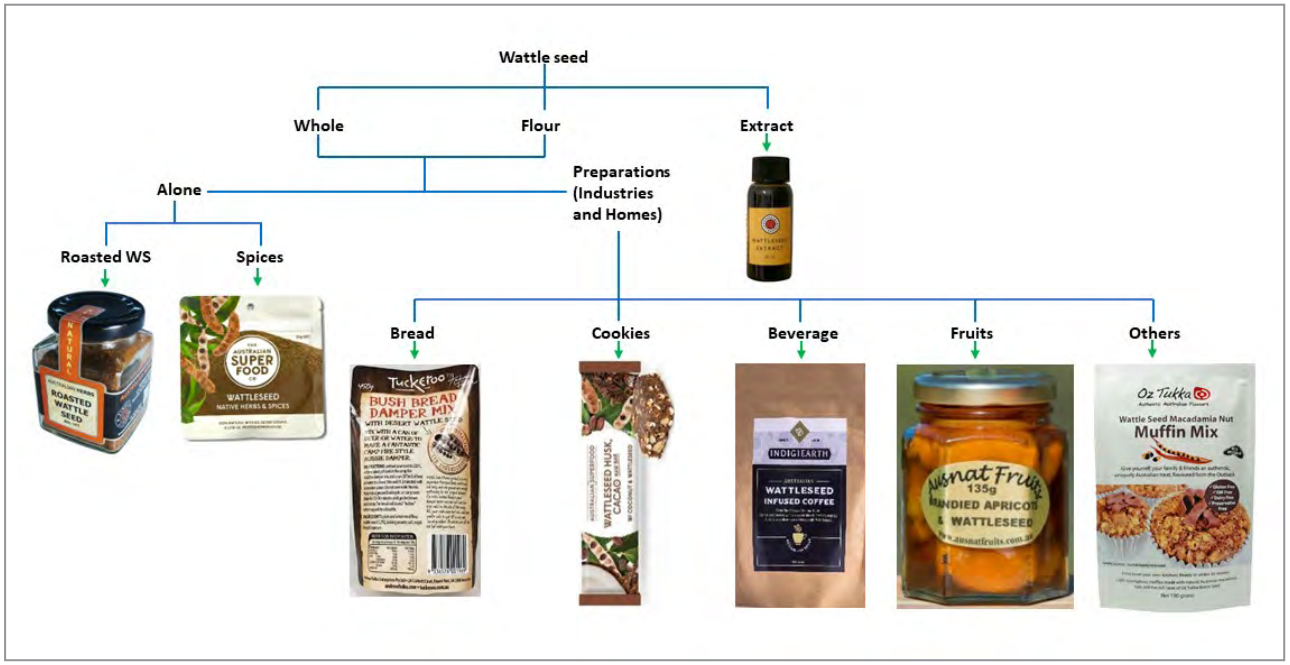

Figure. 4: Pictorial representation of wattle seed products.[6]

Table 2: Rapid sensory profiling of wattle seed roasted in an oven at 180ºC for seven minutes.[12]

Sensory profile	*Acacia retinodes*	*Acacia longifolia ssp. sophorae*
Aroma	Gravy, roasted nuts, onion, lemon	Meaty, yeasty, roasted onion
Flavour	Bitter, peanut	Savoury, onion, nutty
Taste	Savoury, smoky, cucumber	Bitter, savoury

Roasting is the most common method of processing WS, mainly to eliminate the Djenkolic acid and reduce anti-nutrient levels, but also to develop their unique aroma and flavour compounds.

Functional properties and sensory profiles

WS possess high water and oil absorption capacities (2g of water and 0.7g of oil bound per gram of flour) and emulsifying capacity (55-57%).[20] Since WS are usually roasted prior to its use in food products, less roasting time (5-10 min.) should be selected to minimise or prevent loss of functional properties of WS due to prolonged heat.

One of the unique properties of WS is the diversity in sensory attributes between roasted WS species. For instance, *A. retinodes* was reported to have a coffee aroma and nutty flavour while a roasted onion aroma and vegemite flavour was perceived in *A. longifolia ssp. sophorae* by taste panellists.[12] Therefore, the variation in the sensory profiles between species could increase potential applications of WS in the food industry. Moreover, the sensory properties of roasted WS species can be a guide in the selection of appropriate species to be used in food products development.

Projected development of the wattle seed industry

The rise in world population and increase in global warming have necessitated the search for crops that are climate adapted, sustainable, environmentally friendly and highly nutritious, such as WS. WS is a perennial legume and excellent source of plant protein. Previous studies and applications of WS have focused on a few species namely, *A. victoriae, A. coriacea, A. cowleana, A. saligna* and *A. retinodes.*

With the increase in demand for WS and a shift from wild harvest to orchard production, more studies are required to assess the nutritional and sensory profiles as well as toxicological assessment of cultivated fast-growing edible species such as *A. longifolia ssp. longifolia*, *A. baileyana, A. pycnantha* and others, prior to their use as functional ingredients in human foods.

Conclusion

WS is a vast untapped golden resource - an ancient grain, but a new environmentally sustainable, climate adapted perennial grain legume for human food.

WS is a highly nutritious human food, rich in protein, dietary fibre, potassium and iron.

A large range of food products can be produced from roasted WS seed due to the diversity in the nutritional, functional and sensory profiles of different WS species.

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