

Environment friendly products from black wattle

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Received 12 January 2007; accepted 22 February 2007

Abstract

Black Wattle (*Acacia Mearnsii*) is a valuable tree, which grows in the altitude range of 2000-4500 feet and having a minimum annual rainfall of 35 inches. The black wattle tree has got wide range of uses as specialty timber, pulpwood, firewood, tannin extract, flocculent, Base Exchange material etc. Vegetable tannin prepared from black wattle bark is used world wide for tanning the light sole leather. In this paper the climatic requirements for the growth of Black Wattle are listed. The distribution of tannin in various parts of Black Wattle tree is reported. The stripping of bark and various types of bark are discussed. The removal (extraction) of the material from natural resources has been pursued from pre-historic times to the present age. Favorable extraction conditions in the modern tanning industry are also reported. Commercial exploitation of black wattle is solely justified by its use. Comparison of Black Wattle tannin extract with other vegetable extract is made based on significant chemical and physical properties of extracts.

Keywords: Biomass; Black wattle; Extractives

1. Introduction

Black wattle, (*Acacia mearnsii*), a small to medium-sized tree (see Fig 1), is arguably one of the most adaptable and versatile African and Australian native species. It is adaptable because it can be grown on a wide range of sites, and is versatile because it has a potential of producing a large number of products. The commercial value of black wattle tree depends upon several environmental factors. It is very important to understand about the site quality, annual rain fall, and annual average temperature etc. before black wattle plantations, as the tannin content depends on this aspects. It is very important to consider following aspects for raising the commercial value of black wattle tree:

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1. 1. Climatic requirements for growth of black wattle tree.
1. 2. Distribution of tannin in black wattle tree.

1. 1. Climatic requirement for growth of black wattle

Black tree grows most successfully mainly in the deep fertile soil of so called “mist-belt”, areas of Africa located within the altitude range of 2000-4500 feet and having a minimum annual rainfall of 35 of inches. At higher altitude, frost and snow damage limit the growth while in the milder coastal regions recurrent cycles of insect pest are difficult to control. This kind of climatic conditions are fairly available in Africa (particularly Kenya) and in Australia. The afore mentioned susceptibility of black wattle to frost damage and insect attack as well as poor quality of soils and lower & irregular rainfall are main reasons for poor cultivation of black wattle in Indian subcontinent. Fig. 1. shows the natural form of Black Wattle tree and its plantation.



Fig. 1. Natural form of black wattle tree and its plantation.

1. 2. Distribution of tannin in black wattle

In all *acacias* the tannins and their associated non-tannins are concentrated mainly in the bark. Table 1 shows the distribution of tannins and their associates.

Table 1. Distribution of tannins and its associated non-tannins in black wattle.

Portion of Tree	% Tannins	% Non-Tannins	% Insoluble	% Moisture
Barks (dry)	38.6	10.3	43.0	8.1
Leaves only	4.9	8.4	44.8	41.9
Leafless twigs	3.6	5.9	44.6	45.9
Upper stem	0.4	6.7	92.9	-
Stem base	1.6	3.3	95.1	-
Roots	12.7	13.5	73.1	10.0
Pods	21.6	13.5	51.8	13.1

Mature Black wattle (8-10 years growth) contains on average 35% tannin. The tannin content of the bark varies within a single tree, being highest in the thick basal bark and gradually decreasing with increasing height. The bark of lowest tan content can therefore be found in the youngest portion trunk and branches. Tannin content usually increases with increasing age and thickness of bark, but varying soil conditions, rainfall and other environmental factors also exercise a marked influence. A higher correlation exists between the diameter of the tree at the breast height and tannin content. Tannins occur in all plant parts but commercially they are derived only from bark.

2. The stripping of the bark and extraction

Black wattle trees after reaching maturity are felled and stripped of bark during the period of October to June, when the soil moisture content is high (in Kenya). The trees strip easily and almost continuously in areas of high rainfall, but with difficulty in dry areas or after a sudden drop of temperature.

The stripped bark may either be sent directly to the extract factories, where bark is preferred in the green condition, or else prepared for storage for export by drying. The color of dried bark is of great importance in grading. Preliminary drying is satisfactory under fine conditions, but as the stripping of the trees usually takes place in the wet season, the drying bark may be subjected to rain if not covered. Continued moist conditions cause serious discoloration of the bark, especially on the inner surface and many result in loss of 'Non-Tans'. Moist conditions can also bring about loss of tannins by fermentation of green bark in pile. Direct sunlight also accelerates discoloration and shade-drying is usually recommended and used. Once thoroughly dried, the tannin in the bark appears stabilized to oxidative darkening and any subsequent color increase is very gradual.

In early days of wattle industry, dry bark was the raw material for the manufacture of extract but with suitable extraction conditions, it is now preferable to process the bark in the green form straight from the plantation. By this means, tannin extract GS (*Green Special*) of superior quality in tannin and color is obtained. But, as a precautionary measure, stick bark (dried bark) is maintained in stock at the factories in case of any emergency or deficiency in the supply of green bark, as the stripping closes with the approach of winter. The shade dried stick bark is shown in Fig. 2. The weight of each bundle varies between 6-10, for ease of lifting and carrying manually by labors. Black wattle bark extractives are readily soluble in hot water. In tanneries the bark is broken up and extracted by a hot counter current leaching. Alternately the bark is first cold leached and finally hot leached to remove all solubles. The hot and cold extractives are said to

have different tannin properties. The tannin is a basis tannin material adaptable to the conditions and customs of tannage in over 60 countries that are conversant with its use, and generally the properties and characteristics of the extract permit the tanner to modify the material (leather) for his own purpose.



Fig. 2. Shade dried stick bark packed in bundles.

The Tannin extract manufacturing industry is very much alive in names of Kenya Vegext (EPZ) Limited, located about 25 Km. from Nairobi and Kenya Tanning extracts, Thika, Kenya.. Kenya Vegext produces two prime products for the Tanning Industry, namely GS (Green Special) and OP (Ordinary Powder). Green special is prepared from fresh green bark. Even though the moisture content of bark is more when it is green, it has other major advantage in terms of quality of extracts. The bark is supplied immediately after major advantage in terms of quality of extract. The bark is supplied immediately after stripping. The suppliers of the bark take care that bark does not deteriorate. A high price is offered for bark in green conditions in most of tanning extracts industry, thus encouraging the supplier of bark for supplying bark in good and green conditions. The bark is usually stripped in rainy seasons, when it is raining. The percentage of tans is high in the bark, if it is stripped while raining. Considerable decrease in insolubles, alcohols and non-tans is observed at the same time.

It is almost impossible to get fresh and green bark round the year. But there is a demand of vegetable tannin extract (also known as wattle extract), from several countries particularly Italy, Pakistan and India for high quality tanning of sole leather. For this reason the bark is stripped while it is raining, and then it is shade dried (Fig. 2). The shade dried bark is can be processed as per the demand of extract. The finished tannin extract in powdered or solid form is highly sensitive to sunlight. It is also hygroscopic in nature and has got a shelf life. For this reason

tannin extract industry prefers to process the bark as per the demand to maintain the quality of finished extracts.

In the most modern wattle extract industry, Wattle Extract is produced by making use of series of tall reactors (called as autoclaves or vat), which uses counter-current technique of leaching. A suitable number of autoclaves are usually situated above floor level for convenience in removing the spent bark. The series of few autoclaves constitutes a battery of autoclaves interconnected with a circuit of metal piping having the requisite by-pass valves to control the movement of the extracting medium. Hot water is pumped into the vat containing the most extracted bark and is transferred to next vat in series by intermediate pumps. When the bark becomes spent of its extractives it is discharged usually by manual labor through a manhole situated at the bottom of vat. The preparation of powdered form of wattle extract consists essentially of a simple process of counter-current extraction (leaching) with hot water followed by high-pressure triple effect evaporation and spray drying. In spite of its simplicity, considerable attention is given in the modern factory to the accurate sampling and analysis of raw materials, extract, spent bark and intermediates. Few minor chemicals in due proportion are added to the extracted liquor in order to maintain the quality of extract. The names and proportions of those chemicals are kept confidential due to commercial considerations.

3. Various uses of black wattle tree

Black wattle has the potential to produce a wide range of products [1-4], including specialty timber, firewood, pulpwood, tannin and posts. However in many cases markets are not yet developed and there is a scope for new processing industries.

3. 1. Specialty timber

Black wattle timber, although lighter in color, is similar to that of Blackwood, which has established a good timber markets. It has attractive light brown heartwood with reddish markings and distinctive pale sapwood. It is very hard and tough, with moderate strength and durability and fine textured grain, which is often crossed or interlocked. The wood is moderately easy to work and takes a good polish. It is reported to have densities that range from 650-945 kg/m³. To date, Black wattle processing is uncommon, but reports [3] indicate that it is quite easy to saw and is not prone to collapse or excessive shrinkage when dried. It may exhibit minor surface checks, which can be overcome by slow drying techniques.

Production of saw logs is only likely to be possible on sites with at least 700 mm/year rainfall and high soil moisture availability. Black wattle timber, which can be produced in half the time of Blackwood, has most of the admired properties of its sister species. It could be marketed as a cheaper version of Blackwood or, as timber markets evolve, in its own right as a specialty timber species. Fast growth rates (8-10 years), minimal processing problems and attractive timber which is easy to work, make Black wattle a specialty timber option for consideration on high quality sites.

3. 2. Firewood

Black wattle is excellent hot burning firewood that was traditionally prized for wood fired baker's ovens. This, along with fast growth rates and cheap establishment techniques such as direct seeding, make Black wattle a popular choice for firewood production. Firewood can also be produced from thinning from plantations destined for timber production.

3. 3. Pulpwood

Black wattle is widely grown in South Africa for pulpwood. It gives high pulp yields with the Kraft method, requires low chemical usage in the pulping process and provides favorable paper strength properties. As mixed wood chips (of different species) is undesirable, export pulpwood companies indicate that the minimum feasible volume of Black wattle chips they would require would be in the order of 60, 000 to 100, 000 green tones/year. This would require large areas of Black wattle plantations. It is unlikely however, that Black wattle will be established for pulpwood in areas that are suitable for growing Blue gum, (*Eucalyptus globulus*) which is considered the world's best wood chip species. In lower rainfall areas, which are unsuited to Blue gum, Black wattle growth rates and persistence may suffer.

3. 4. Tannin

The exploitation of the Black Wattle has been justified solely by the valuable bark it produces. The bark of Black wattle is noted for its high tannin content, (36-44%), depending on site quality. Black wattle bark supported a thriving tanning industry late last century. Among reasons cited for the decline in the Black wattle tanning industry are the increased use of chromium salts in tanning and competing imports of tannin extract. Today there are very few tannin extract industries in Kenya (namely Kenya Vegext (EPZ) limited, Nairobi and Kenya Tanning Extracts, Thika) which uses bark from Black wattle grown in Kenya. Its requirements of bark are met from bark stripped from nearby plantations. The bulk of this is used in the production of wood adhesives for the reconstituted particleboard industry. Industry development for tannin production is dependent on development of a tannin extraction processing industry and innovative methods for bark stripping to compete with low labor costs. The absence of a large Black wattle plantation resource that would guarantee a raw product, and fierce competition on the world tannin market driving prices down, are the main reasons for the industrialist to invest in tannin processing area. Table 2 gives the average chemical composition of wattle extract in various forms. The data is obtained from author's wide range of study and experience in the field of design, operation and management of world class Tannin Extract industry.

3. 5. Wattle extract for dust control

Wattle extract is useful for horticulturists who are plagued by the dust problems. The wattle extract is mixed with preferably hot water. The mixing will take longer time with cold water. This mixture reacts with the soil and creates a hard surface that lasts for about 2 months with reasonable traffic. The wattle extract is not toxic; it is naturally biodegradable vegetable extract. The reaction with the soil or dust, in the dust control application, changes the tannin to 'ferric-

tannate' which is partially waterproof, i.e. rain fast. The extract also acts as a temporary herbicide, i.e. grass will not grow again for about 2 months.

Apart from the above mentioned uses, tannin extract (in powdered form) is also used in oil well drilling (as flocculent) and as Base Exchange material.

Table 2. Typical chemical composition and property of extract in bark and products

	Tannin	Non-tannins	Insolubles	Fibre	Moisture	Total %	Reds	Yellows
Green bark	20.2	5.7	0.1	21.3	52.8	100	--	--
Solid extract	63.7	18.8	0.2	--	17.3	100	1.8	3.8
OP extract	69.9	21.6	0.3	--	8.2	100	1.3	2.7
GS extract	68.5	23.6	0.3	--	7.7	100	0.2	0.1

4. Comparison of black wattle tannin extract with other vegetable extracts

It is common knowledge that the quality of leather produced during any tannin process depends on the chemical nature of the extract as well as the manner in which it is used.

Significant chemical and physical properties of extracts are

- 1) The constitutional nature of tannin
- 2) The stability of tannin to enzymatic and atmospheric oxidation (which determines their stability)
- 3) The stability of tannins to condensation at different pH and temperatures.
- 4) The relation between average molecular weight, molecular size, solubility and the affinity of the tannin for collagen.
- 5) The chemical nature of the non-tannins including their minerals content; their acid content and acid type present and their stability to fermentation.
- 6) The insoluble content of the extract and ease of formation of insolubles in relation to the time, temperature and concentration
- 7) The viscosity of extracts solutions.

Some of those properties have already been related to the physical properties of the resultant leather, but due to the complexity of the extract the leather chemist awaits the analysis and structural elucidation of almost all the commercially important vegetable extracts now in use.

Wattle extracts have a relatively high pH value (usually 4-6); low salt and acid content (35 to 60 mg equivalents /liter); relatively low viscosity and high solubility. The last mentioned property makes wattle extract particularly useful for tanning material, where by appropriate additions, the compositions of the wattle liquor may be adjusted for any purpose. Unlike other condensed tannins, wattle extracts do not readily precipitate over the pH range 1-4 and compare favorably with hydrolysable tannins in this respect. On account of their higher solubility, wattle extracts do not easily precipitate from aqueous solution on the addition of salts, as compared with other condensed tannins. Wattle tanned leather tends to become red in color when exposed to Sunlight or UV light. This disadvantage is, however common to condensed tannins.

Leather chemists have published tables comparing the speed of tannage and amounts of tannins fixed using various vegetable extracts. Shuttleworth [5] has reviewed this work and has demonstrated that much of it has failed to take into account the effects of pH and the various non-

tannins (acid, salts, sugars and gums). He has shown that where reasonable cognizance is taken to these differences, wattle extract compare favorably with others when correctly used in the tannery. Both Woodhead [6] and Shuttleworth [5] have shown that the natural wattle or mimosa extract is ideally suited for ultra-rapid commercial sole-leather tannage.

5. Conclusions

The potential of black wattle tree for various uses is discussed. Black wattle tree is useful from all its parts ranging from bark, leaf to roots. The use of wattle tree as a specialty timber, pulpwood, firewood etc is discussed. The bark of wattle tree is used to produce a Tannin Extract in powdered and solid form. Few details about the process are discussed. The tannin extract is widely used for tanning of sole leather. Apart from this, the tanning extract has the potential of being used as a flocculants, in dust control and in adhesives. Black wattle tree is found to provide several environmental friendly products and its plantations will indeed lead towards betterment of environment.

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