Forest Research
Open Access
ISSN: 2168-9776

Maiti et al., Forest Res 2016, 5:1
DOI; 10.4172/2168-9776.1000162

Research Article Open Access

Variability in Epicuticular Wax in 35 Woody Plants in Linares, Northeast Mexico

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Abstract

A study has been undertaken on epicuticular wax on the leaves of 35 woody species in Linares, Northeast Mexico at the experimental station of Facultad de Ciencias Forestales, Universidad Autonoma de Nuevo Leon, located in the municipality of Linares. Considerable variation in wax accumulation was found among species showing prominent interspecific variation. Wax load varied from 11.18 to 702.04 μg/cm^2 among species studied during summer. Few species selected with high epicuticular wax viz, *Forestiera angustifolia* (702.04 μg/cm^2), *Diospyros texana* (607.65 μg/cm^2), *Bernardia myricifolia* (437.53 μg/cm^2), *Leucophylum leucocephala* (388.50 μg/cm^2), during summer which could well be adapted under semi-arid environments for their efficiency in the reflection of radiation load, reduced transpiration, gas exchange and probably impart drought resistance. The large variations in epicuticular wax could be related to their physiological functions such as transpiration, gas exchange, water relations etc.

Keywords: Epicuticular wax; Variability; Woody tress; Physiological function; Adaptation

Introduction

Leaves contain waxy coating. Environmental conditions may strongly influence the quantity, composition, and morphology of the waxy coverings of leaf surfaces. Wax and cutin function as primary components of the leaf cuticle covering the leaf epidermal cells [1]. Waxes are composed of long-chain paraffins, alcohols, ketones, esters and free fatty acids in proportions determined by both genetic capability and environmental factors [2-4]. Epicuticular wax enhances the reflectance of visible and near infrared radiation from leaf surface thereby reducing net radiation and cuticular transpiration and seems to contribute drought resistance of plants [5-7]. These waxes also impart resistance to plants to absorption and penetration of foliar-applied herbicides [4,8,9]. It has been reported that leaves of mesquite (*Prosopis* spp.) develop a thick waxy cuticle [10,11]. An increase in wax accumulation was observed with leaf maturity in velvet mesquite (*P. velutinu*), while [12] observed most rapid wax accumulation on honey mesquite (*P. glandulosa*) with early leaf development and expansion.

Researches undertaken on epicuticular wax under controlled condition have documented various factors such as, light level [13,14] photoperiod [15] temperature [14,16] and water stress [17-19] influencing the wax contents in leaves. Variations in wax properties can affect the cuticar functions such as, regulation of gas exchange and transpiration, protection against pathogens, and absorption of foliar-applied chemicals as herbicides in agriculture. Few studies are available on variation in epicuticular wax characteristics among plants growing in the field. It has been reported by [20] that the composition and quantity of epicuticular waxes of shrubs in a semiarid environment showed seasonal variations in temperature and rainfall, and both cuticular and total transpiration appeared to be affected with changes in wax composition. Ecotypic variation in the quantity and composition of waxes on leaves of salt cedar (*Tamarix pentandra* Pall.) was considered as the basis of differences among populations in sensitivity to herbicide sprays [4]. Leaves of a cabbage cultivar (*Brassica oleracea* L. var. capitata), tolerant of foliar applications of the herbicide nitrofen (2,4-dichlorophenyl-p-nitrophenyl ether) were more heavily waxed than an intolerant cultivar [21]. The heavier wax deposit on leaves of the tolerant cultivar substantially decreased the rate and extent of herbicide penetration of the cuticle. The development of leaf cuticle of velvet mesquite was investigated [22] and detected well defined crystalline wax structures on even the youngest leaves. The amount of wax appeared to increase with leaf maturity, and a dendritic-shaped wax plate was formed in July in addition to the small, linear structure already present. The epicuticular wax structure of five *Prosopis* species, consisted of an aggregate coating of rods and dendritic platelets [23].

Materials and Methods

The study was under taken in thirty five woody trees species in the summer season (June 2015) at the experimental station of Facultad de Ciencias Forestales, Universidad Autonoma de Nuevo Leon, located in the municipality of Linares. Fresh leaves from different woody plant species were collected from the forest. Then leaflets were separated individually to complete a sub sample having an approximate surface area of 100 cm^2 which is determined by a leaf area meter. Sub-samples were gently rinsed in distilled water to remove foreign material, then air dried, and then placed in a beaker with 40 ml of analytical grade chloroform (99% pure) heated to 45°C. After 30s the chloroform was poured into preweighed foil pans which were then placed in a well-ventilated laboratory and evaporated to dryness for 24 hours. Foil pans were then reweighed to quantify the amount of residual wax. Amount of wax for a field sample was the mean of 5 laboratory replications. Wax

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Received Deceber 04, 2014; **Accepted** December 30, 2015; **Published** January 01, 2016

Citation: Maiti R, Rodriguez HG, Gonzalez EA, Kumari A, Sarkar NC (2016) Variability in Epicuticular Wax in 35 Woody Plants in Linares, Northeast Mexico. Forest Res 5: 162. doi:10.4172/2168-9776.1000162

was calculated reported on a weight per area basis (g m^{-2}) derived by dividing wax weight by the actual area of the sub-sample unit.

Results and Discussion

The present study indicated the presence of large variations in the wax contents among the different woody tree species studied. The results obtained are presented below. Table 1 gives the summary of Kwalis analysis. Table 2 presents the epicuticular wax content in 35 woody species. The species showed significant variation in epicuticular wax contents among these 35 species. These variations are seen in Figure 1. Most of the tree species has shown a large variation in the wax contents. The wax contents in these thirty five woody species ranged from 11.18 to 702.04 µg/cm^2. On the basis of total epicuticular wax contents species are selected and categorized into high, medium and low wax content species.

The species showing high epicuticular wax load are *Forestiera angustifolia* (702.04 µg/cm^2), *Diospyros texana* (607.65 µg/cm^2), *Bernardia myricifolia* (437.53 µg/cm^2), *Leucophylum leucocephala* (388.50 µg/cm^2), *Acacia farnesiana* (373.49 µg/cm^2), *Cercidium macrum* (308.63 µg/cm^2). Similarly the species showing medium epicuticular wax load are *Lantana macropoda* (294.86 µg/cm^2) *Quercus polymorpha* (199.40 µg/cm^2), *Parkinsonia aculeata* (196.20 µg/cm^2), *Acacia shaffneri* (170.04 µg/cm^2), *Diospyros palmeri* (163.25 µg/cm^2), *Helietta parvifolia* (151.19 µg/cm^2), *Eysenhardtia polystachya* (138.49 µg/cm^2), *Bumelia celastrina* (*132.38* µg/cm^2*)* while the species showing minimum epicuticular wax are *Ehretia anacua* (17.58 µg/cm^2), *Karwinskia humboldtiana* (15.47 µg/cm^2), *Amyris texana* (11.18 µg/cm^2). The rest of the species had near medium to very low wax content are shown in the Table 1.

The results reveal that there exists large variability in epicuticular wax accumulation among 35 species. This large variability in interspecific

	Statistical	
Variable	χ^2	Valor p
Epicuticular wax (µg/cm²)	120.5	< 0.001

Table 1: Summary of Kwalis Analysis.

Scientific name	Family	Type	Wax µg/cm²
Helietta parvifolia	Rutaceae	Shrub	151.19 ± 82.29
Amyris texana	Rutaceae	Shrub	11.18 ± 12.87
Leucophylum leucocephala	Scrophulariaceae	Shrub	388.50 ± 78.74
Zanthoxylum fagara	Rutaceae	Shrub	63.98 ± 16.47
Karwinskia humboldtiana	Rhamnaceae	Shrub	15.47 ± 8.54
Celtis pallida	Ulmaceae	Shrub	75.64 ± 57.13
Guaiacum angustifolium	Zygophyllaceae	Shrub	122.50 ± 123.36
Bernardia myricifolia	Euphrobiaceae	Shrub	437.53 ± 221.86
Forestiera angustifolia	Oleaceae	Shrub	702.04 ± 392.57
Croton suaveolens	Euphrobiaceae	Shrub	62.97 ± 11.03
Eysenhardtia polystachya	Fabaceae	Shrub	138.49 ± 32.32
Cordia boissieri	Boraginaceae	Tree	89.52 ± 26.02
Ehretia anacua	Boraginaceae	Tree	17.58 ± 5.50
Caesalpinia mexicana	Fabaceae	Tree	38.49 ± 10.86
Condalia hoockeri	Rhamnaceae	Tree	59.46 ± 49.54
Sargentia gregii	Rutaceae	Tree	55.44 ± 19.31
Diospyros palmeri	Ebenaceae	Tree	163.25 ± 41.34
Bumelia celastrina	Sapotacee	Tree	132.38 ± 45.90
Ebenopsis ebano	Fabaceae	Tree	62.71 ± 30.12
Leucaena leucocephala	Fabaceae	Tree	59.18 ± 16.01
Celtis laevigata	Ulmaceae	Tree	34.25 ± 15.93
Cercidium macrum	Fabaceae	Tree	308.63 ± 176.60
Acacia rigidula	Fabaceae	Shrub	31.24 ± 10.45
Gymnosperma glutinosum	Asteraceae	Shrub	65.12 ± 21.62
Acacia farnesiana	Fabaceae	Shrub	373.49 ± 217.84
Lantana macropoda	Verbenaceae	Shrub	294.86 ± 84.36
Berberis chococo	Berberidaceae	Shrub	98.65 ± 58.50
Diospyros texana	Ebenaceae	Tree	607.65 ± 228.73
Acacia berlandieri	Fabaceae	Tree	58.15 ± 17.84
Quercus polymorpha	Fabaceae	Tree	199.40 ± 140.81
Salix lasiolepis	Salicaceae	Tree	42.96 ± 20.81
Acacia shaffneri	Fabaceae	Tree	170.04 ± 86.08
Prosopis laevigata	Fabaceae	Tree	103.73 ± 23.65
Parkinsonia aculeata	Fabaceae	Tree	196.20 ± 63.25
Acacia wrightt	Mimosaceae	Tree	114.48 ± 38.05

Table 2: Epicuticular wax contents (µg/cm²) in 35 woody species in Northeast Mexico.

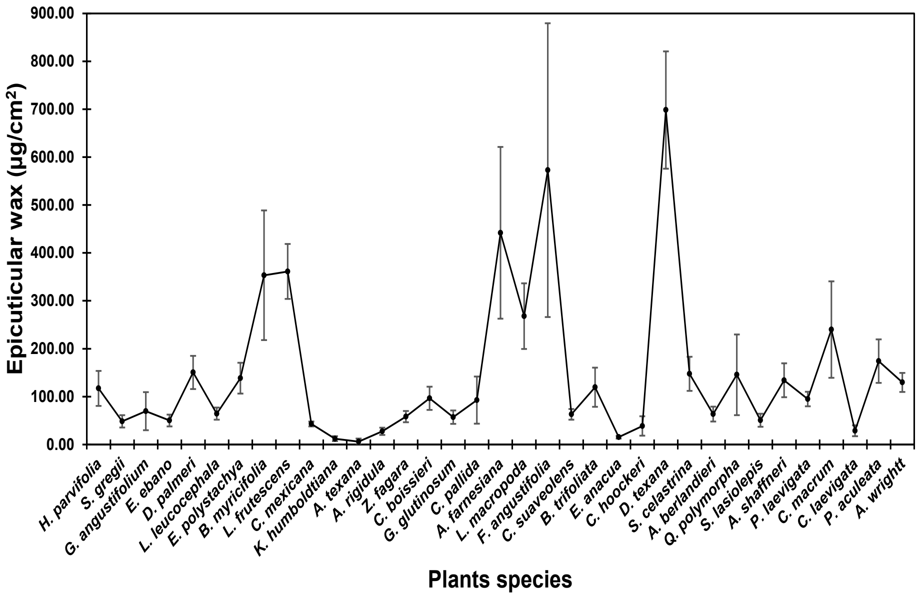

Figure 1: Epicuticular wax content of 35 woody species.

variation in epicuticular wax contents among among different species are rarely found, although [24] demonstrated variability in wax content among different species of *Prosopis* and in different seasons.

The large variation in epicuticular wax observed in the present study could be related to physiological function and adaptation of the species to varying environments. With respect to the physic-chemical and physiological functions it has been reported that epicuticular wax enhances the reflectance of visible and near infrared radiation from leaf surface, which in turn reduce net radiation and cuticular transpiration and seem to contribute drought resistance of plants [5-7]. The presence of wax impart resistance of plants to absorption and penetration of foliar-applied herbicides [4,8,9]. We selected few species with high epicuticular wax viz, *Forestiera angustifolia* (702.04 μg/cm^2), *Diospyros texana* (607.65 μg/cm^2), *Bernardia myricifolia* (437.53 μg/cm^2), *Leucophylum leucocephala* (388.50 μg/cm^2), during summer which could well be adapted under semi-arid environments for their efficiency in the reflection of radiation load, reduced transpiration, gas exchange and probably impart drought resistance. They could impart resistance to insect attack and herbicide penetration as reported by few authors [4,8,9].

Few studies are available on variation in epicuticular wax characteristics among plants growing in the field. The large variations in epicuticular wax could be related to their physiological functions such as transpiration, gas exchange, water relations etc. The result of epicuticular wax of the species reported in the present study was undertaken in the summer. The wax content was reported to vary in different environments [13,14], photoperiod [15], temperature [14,16] and water stress [17-19]. It has been reported by [20] that the composition and quantity of epicuticular waxes of shrubs in a semiarid environment showed seasonal variations in temperature and rainfall, and both cuticular and total transpiration appeared to be affected with changes in wax composition. We claim this is the first research ever dealt with the analysis of epicuticular wax in a large number of woody species.

Conclusion

It is well documented that epicuticular wax on leaf surface play an important role in the physiological function and adaptation of trees in an ecosisystem with respect to loss of transpiration owing to the reflection of solar radiation, and other aspects such as gas exchange, water stress, herbicide resistance etc. The present study show a large variations in the contents of epicuticular wax thereby giving opportunity to select species for future research with respect to the adaptation of these species to semiarid environment. The species selected with high epicuticular wax contents viz., *Forestiera angustifolia* (702.04 μg/cm^2), *Diospyros texana (*607.65 μg/cm^2), *Bernardia myricifolia (*437.53 μg/cm^2), *Leucophylum leucocephala (*388.50 μg/cm^2) may be well adapted to the semi-arid conditions. Future research needs to be directed on these selected species with special reference to their physiological function and adaptation to water stress.

Acknowledgement

The authors are highly thankful to Elsa Gonzalez for dedicated hard work in the chemical analysis.

References

1. Martin JT, Junier BE (1970) The cuticles of plants. St. Martin's, New York.
2. Femandez AMS, Baker EA, Martin JT (1964) Studies on plant cuticle-VI. The isolation and fractionation of cuticular waxes. Ann. Appl. Biol,53: 43-58.
3. Hull HM, Went FW, Bleckmanu CA (1979) Environmental modification of epicuticular wax structure of Prosopis leaves. J. Arizona- Nevada Acad. Sci. pp. 1439-1442.
4. Wilkinson RE (1980) Ecotypic variation of Tamarix pentandra epicuticular wax and possible relationship with herbicide sensitivity. Weed Sci. 28: 110-113.
5. Kurtz EB (1950) The relation of the characteristics and yield of wax to plant age. Plant Physiology, 25: 269-278.
6. Ebercon A, Blum A, Jordan WR (1977) A rapid calorimetric method for epicuticular wax content of sorghum leaves. Crop Sci., 17:179-180.
7. Hull HM, Bleckmm CA (1977) An unusual epicuticular wax ultrastructure on leaves of *Prosopis famarugo*. Amer. J. Bot. 64: 1083-1091.
8. Hammerton JL (1967) Environmental factors and susceptibility to herbicides. Weeds, 15: 330-336.
9. Sharma MP, Vanden Born WH (1970) Foliar penetration of picloram and 2, 4-D in aspen and balsam poplar. Weed Sci. 18: 57-63.
10. Hull HM (1970) Leaf structure as related to absorption of pesticides and other compounds. Residue Rev, 3l: l-155.
11. Meyer RE, Morton HL, Haas RH, Robiaon, ED, Riley TE (1971) Morphology and anatomy of honey mesquite. U.S. Dep. Agr. Tech. Bull. 1423: 186.
12. Mayeux HS, Jordan WR, Meyer RE, Meola SM (1981) Epicuticular wax on goldenweed (*Isocoma* spp.) leaves: variation with species and season. Weed Sci, 29: 389-393.
13. Juniper BE (1960) Growth, development, and effect of the environment on the ultra-structure of plant surfaces. J. Linnean Soc. Bot. 56: 413-418.
14. Reid DW, Tukey JR (1982) Light intensity and temperature effects on epicuticular wax morphology and internal cuticle ultrastructure of carnations and Brussels sprouts leaf cuticles. J. Amer. Soc. Hort. Sci, 107: 417-420.
15. Wilkinson RE (1972) Sicklepod hydrocarbon response to photoperiod. Phytochemistry. 11: 1273-1280.
16. Hull HM (1958) The effect of day and night temperature on growth, foliar wax content, and cuticle development of velvet mesquite. Weeds, 6: 133-142.
17. Skoss JD (1955) Structure and composition of plant cuticle in relation to environmental factors and permeability. Bot. Gaz. 117: 55-72.
18. Bengtson C, Larson S, Liljenberg (1978) Effects of water stress on cuticular transpiration rate and amount and composition of epicuticular wax in seedlings of six oat varieties. Physiol. Plantarum. 44: 319-324.
19. Baker EA, Procopiol J (1980) Effect of soil moisture status on leaf surface wax yield of some drought-resistant species. J. Hort. Sci. 55: 85-87.
20. Rao JVS, Reddy KR (1980) Seasonal variation in leaf epicuticular wax of some semiarid shrubs. Indian J. Exp. Biol. 18: 495-499.
21. Preira JF, Splittstoesser WE, Horen HJ (1971) Mechanism of intraspecific selectivity of cabbage to nitrofen. Weed Sci. 19: 647-651.
22. Hull HM, Morrison, Orton HL, Wharrie JR (1975) Environmental influences on cuticle development and resultant foliar penetration. Bot. Rev. 41: 421-452
23. Bleckmann CA, Hull HM (1975) Leaf and cotyledon surface ultrastructure of five Prosopis species. J. Ari- zona Acad. Sci. 10: 98-105.
24. Jacoby PW, Coby, Ansley RJ, Medores CH, Huffman AX (1990) Epicuticular wax in honey mesquite: Seasonal accumulation and intraspecific variation. Journal of Range Management, 43: 347-350.