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Antioxidant Properties of Sugarcane Extracts

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The role of dietary antioxidants in protecting tissues and cells against harmful effects of free radicals has been widely publicized (Weller, 1999), and numerous preparations extracted from natural sources are available to the public as dietary supplements (Prior and Cao, 1999). A purified extract of bilberry, for example, rich in anthocyanins, was found to be effective in human subjects for reducing the clinical symptoms of lowered capillary resistance and increased retinal sensitivity. Extracts of strawberry and spinach were found to enhance the age-related functions of brain in rats, while blueberry extracts reduced the lung damage in rats subjected to pure oxygen. Extracts of green tea, Gingko biloba, grape seed and many others, and their therapeutic effects, are well known.

Table I: Antioxidant properties (ORAC values in μmole TE/100 g) of various high-antioxidant fruits and vegetables (Weller, 1999)

Prunes	**5,800**
Raisins	**2,800**
Blueberries	**2,400**
Oranges	**750**
Red grapes	**700**
Kale	**1,800**
Spinach	**1,300**

Blackstrap molasses, a byproduct of processing of sugarcane has long been touted for its therapeutic values, mineral contents, etc, albeit with little or no verifiable evidence of biological effects, and is widely available through the health food industry. Only very recently, physiological effects of four types sugar cane extracts were described by Japanese researchers (Nagai et al., 2001; Koge et al., 2002), viz. promotion of resistance against viral and bacterial infections, stimulation of immune response, protection against liver injuries, free radical scavenging activity and growth promotion in chickens.

Oxygen Radical Absorbance Capacity (ORAC) of Sugarcane Products and Extracts

ORAC (Cao et al., 1993, 1995), a quantitative method of measuring the antioxidant activity of plasma, foods, natural extracts, etc., has become a standard, although not unique, method over the last five years, and ORAC values, in µmole TE, Trolox (a soluble analogue of vitamin E, used as a standard) equivalents per 100 g are available in the literature (Table I) for a number of common fruits, vegetables and other antioxidant-rich food supplements. In addition, a more recent refinement has been the differentiation between "fast", "slow" and total or "whole" antioxidant capacity, referred to in the following, respectively, as "95% ORAC", "50% ORAC" and "whole ORAC" (Genox, 2001).

Five common edible molasses products (Table II) available on the U.S.market have been selected and characterized by their composition and antioxidant capacity (Tables II and III). Products A – D are sugarcane-based products, and E is a corn liquor-based product with a minor amount of a sugarcane liquor blended in.

Table II: Five edible molasses products available in the US retail market.

Code	Product
A	Steen's Home Style Molasses
B	Wholesome Foods Organic Blackstrap
C	Mott's Grandma's Molasses
D	B&G Foods Brer Rabbit
E	Karo's Dark Corn with Refiners' Syrup

Table III: Composition of the five edible molasses products. RDS = refractometric dry solids, color in ICUMSA units, all others in g/100 g.

Sample	RDS	Sucrose	Glucose	Fructose	Ash	Color
A	80	33	18	17	3.4	38,300
B	79	35	8	10	5.8	186,800
C	78	30	18	17	3.1	69,000
D	79	30	16	18	4.6	89,400
E	76	2	14	1	0.68	4,000

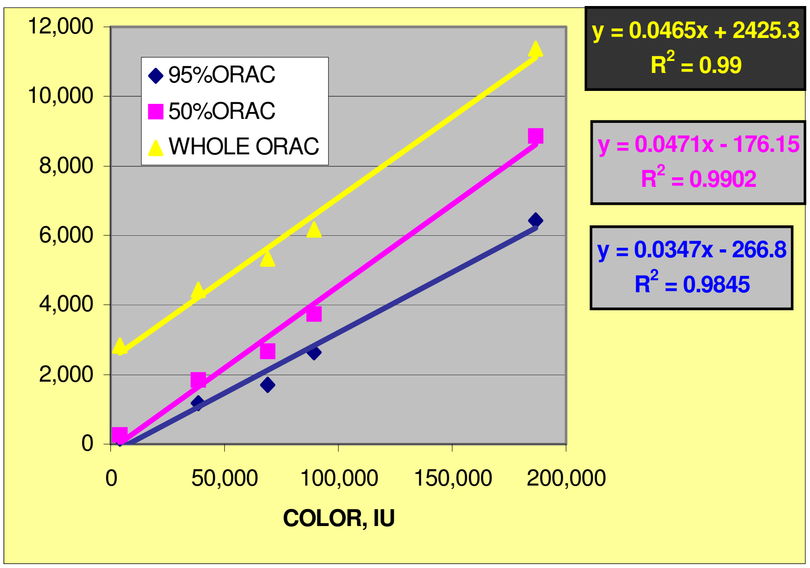
Of the sugarcane products A – D, only B, based on its high color and sugar composition, corresponds to "blackstrap" molasses, the others are lower color products with higher contents of sugars and lower ash.

Table IV: Antioxidant capacity of the five commercial edible molasses products. ORAC in μmole TE/100 g dry solids.

Sample	95% ORAC	50% ORAC	WHOLE ORAC
A	1,170	1,840	4,440
B	6,430	8,860	11,370
C	1,700	2,660	5,340
D	2,640	3,740	6,180
E	160	260	2,830

The antioxidant capacity of the five products correlates very well with their color (Figure 1) because the high antioxidant polyphenol components form a large part of the sugarcane color bodies. With some variations, the "95%" and "50%" ORAC values are much lower than the "whole" ORAC, indicating that a substantial part of the antioxidant capacity is from components with very slow-acting functionality.

Figure 1: Antioxidant capacity of the five edible molasses products correlates well with their color.



Blackstrap molasses is a final product of sugarcane processing that has been subjected to a number of unit operations, and a possibility exists that some of the antioxidant activity has been lost in the process. Samples of Louisiana sugarcane juice and syrups, i.e. sugarcane juice clarified with two different procedures and concentrated under vacuum, were therefore analyzed (Table V). These products have been subjected only to juice extraction, vacuum concentration and, in the case of syrups, to a pH adjustment and settling, and are products with about 80% sucrose on dry solids and a color of about 15,000 ICUMSA units. The ORAC values found are substantially higher than those of the edible molasses and identical for the concentrated juice and syrups, indicating that neither the lime nor soda ash clarification measurably reduced the antioxidant capacity.

Table V: Antioxidant capacity of Louisiana sugarcane juice and syrup. ORAC units per 100 g dry solids.

Sample	95% ORAC	50% ORAC	WHOLE ORAC
Conc. Cane Raw Juice	6,100	10,200	26,400
Cane Syrup - Hot liming	5,700	9,200	27,600
Cane Syrup - Soda ash	5,400	10,000	26,000

Because even prolonged heating of another sample of Louisiana syrup (Table VI) did not result in any reduction of its antioxidant capacity, the high antioxidant capacity of the syrup samples that does not conform to the pattern observed in Figure 1 is yet unexplained. Geographical or varietal differences of sugarcane composition, contact with metal surfaces, air or process chemicals in the industrial process or other factors may be responsible.

Table VI: Antioxidant capacity (ORAC units per 1000 g dry solids) of a Louisiana sugarcane syrup before (F) and after (G) heating for 5 hours at 98 C in a glass container.

Sample	95% ORAC	50% ORAC	WHOLE ORAC
F	7,800	11,400	35,500
G	8,500	12,400	35,000

Application of ion exchange resins for decolorization, removal of polyphenols and other sugarcane colorants from sugarcane liquors is a well established industrial process, and the feasibility was, therefore, explored of applying resins to concentrate the antioxidant-rich compounds contained in the sugarcane juices. An example of such an application is in Table VII, where the antioxidant capacity is given of a syrup and two kinds of extracts or concentrates. While the concentrate 1 exhibits only a minor improvement over the source syrup, the concentrate 2 is a very antioxidant-rich product. The very high proportion of the "fast" antioxidant capacity is remarkable and augurs well for its therapeutic potential.

TableVII: Antioxidant properties (ORAC units per 100 g dry solids) of a Louisiana sugarcane syrup and two extracts prepared from the syrup.

Sample	95% ORAC	50% ORAC	WHOLE ORAC
Sugarcane syrup	4,140	6,724	48,930
Concentrate 1	35,220	45,520	56,870
Concentrate 2	826,000	1,021,000	1,232,000

The whole ORAC capacity of the concentrate 2 is comparable to such well-known antioxidants as caffeic and gallic acids, and exceeds that of many existing commercial antioxidant supplements (Prior and Cao, 1999), and, by a factor of one hundred or more, such health food favorites (Table I) as prunes or raisins. While its physiological functions still need to be established, it is believed that this natural extract could be produced, as a new natural or even organic product from sugarcane processing, at a sufficiently low cost and high volume to aid significantly the antioxidant intake of the population. A 250 mg capsule of this product would satisfy the daily recommended intake of 3,000 ORAC units (Prior and Cao, 1999) considered as minimum to sufficiently increase the serum antioxidant levels.

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