US009410216B2

(12) **United States Patent**
Eyal et al.

(10) **Patent No.: US 9,410,216 B2**
(45) **Date of Patent: Aug. 9, 2016**

(54) **SUGAR MIXTURES AND METHODS FOR PRODUCTION AND USE THEREOF**

(75) Inventors: **Aharon Meir Eyal**, Jerusalem (IL); **Robert P. Jansen**, Collinsville, IL (US); **Revital Mali**, Jerusalem (IL); **Asher Vitner**, Jerusalem (IL)

(73) Assignee: **Virdia, Inc.**, Raceland, LA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/378,657**

(22) PCT Filed: **Jun. 26, 2011**

(86) PCT No.: **PCT/IL2011/000509**

§ 371 (c)(1),
(2), (4) Date: **Jan. 19, 2012**

(87) PCT Pub. No.: **WO2011/161685**

PCT Pub. Date: **Dec. 29, 2011**

(65) **Prior Publication Data**

US 2012/0264873 A1 Oct. 18, 2012

Related U.S. Application Data

(60) Provisional application No. 61/358,894, filed on Jun. 26, 2010, provisional application No. 61/491,243, filed on May 30, 2011, provisional application No. 61/500,169, filed on Jun. 23, 2011.

(30) **Foreign Application Priority Data**

Jul. 8, 2010	(IL)	206896
Jul. 29, 2010	(IL)	207313
Feb. 6, 2011	(WO)	PCT/IL2011/000130

(51) **Int. Cl.**

C13K 1/02	(2006.01)
C12P 7/10	(2006.01)
C12P 19/02	(2006.01)
C12P 19/14	(2006.01)

(52) **U.S. Cl.**

CPC ... ***C13K 1/02*** (2013.01); ***C12P 7/10*** (2013.01); ***C12P 19/02*** (2013.01); ***C12P 19/14*** (2013.01); *A23V 2002/00* (2013.01); *C12P 2203/00* (2013.01); *Y02E 50/13* (2013.01); *Y02E 50/16* (2013.01); *Y02E 50/17* (2013.01)

(58) **Field of Classification Search**

CPC C13K 1/02; C13K 13/00; C13K 13/002; C13K 1/04; C12P 7/10

USPC 127/30, 37

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,344,671	A	6/1920	Bergius
1,391,664	A	9/1921	Bergius
1,457,791	A	6/1923	Norris
1,544,149	A	6/1925	Hagglund
1,547,893	A	7/1925	Bergius
1,688,726	A	10/1928	McKee
1,699,177	A	1/1929	Bergius
1,853,330	A	4/1932	Barstow et al.
1,890,491	A	12/1932	Bergius
1,906,467	A	5/1933	Heath
1,919,623	A	7/1933	Dreyfus
2,146,326	A	2/1939	Bergius et al.
2,239,095	A	4/1941	Hasche
2,293,724	A	8/1942	Faerber
2,305,833	A	12/1942	Warth
2,347,945	A	5/1944	Frey
2,391,149	A	12/1945	Frey
2,440,442	A	4/1948	Hillyer et al.
2,474,669	A	6/1949	Hereng
2,692,291	A	10/1954	Bryan
2,743,219	A	4/1956	Riehm
2,752,270	A	6/1956	Specht
2,778,751	A	1/1957	Riehm
2,890,972	A	6/1959	Wheaton
2,917,390	A	12/1959	Apel et al.
2,937,959	A	5/1960	Reents
2,944,923	A	7/1960	Riehm
2,945,777	A	7/1960	Riehm
2,951,775	A	9/1960	Apel
2,989,569	A	6/1961	Apel
3,067,065	A	4/1962	Kusama
3,132,051	A	5/1964	Nobile et al.
3,251,716	A	5/1966	Porter

(Continued)

FOREIGN PATENT DOCUMENTS

CA	2735396	A1	11/2010
CN	101016703	A	8/2007

(Continued)

OTHER PUBLICATIONS

Michalka, Optimization of Sugar Consumption in the Fermentation of Temulose for Ethanol Production, 2007.*

Helnonan, Ind. Eng. Chem. Res. 2010, 49, 2907-2915.*

International search report and written opinion dated Mar. 9, 2012 for PCT/IL2011/000509.

U.S. Appl. No. 13/132,573, filed Sep. 15, 2011, Baniel et al.

U.S. Appl. No. 13/195,721, filed Aug. 1, 2011, Jansen et al.

U.S. Appl. No. 13/316,327, filed Dec. 9, 2011, Jansen et al.

U.S. Appl. No. 13/320,535, filed Nov. 14, 2011, Jansen et al.

U.S. Appl. No. 13/380,504, filed Jan. 19, 2012, Eyal.

U.S. Appl. No. 13/499,638, filed Apr. 1, 2012, Eyal et al.

U.S. Appl. No. 13/491,485, filed Jun. 7, 2012, Jansen et al.

ADM corn 42/43 syrup. Typical data information. Accessed Oct. 5, 2012.

(Continued)

Primary Examiner — Liam J Heincer

(74) *Attorney, Agent, or Firm* — Wilson Sonsini Goodrich & Rosati

(57) **ABSTRACT**

A sugar mixture comprising: monosaccharides; oligosaccharides in a ratio ≥0.06 to total saccharides; disaccharides in a ratio to total saccharides ≥0.05; pentose in a ratio to total saccharides ≥0.05; at least one alpha-bonded di-glucose; and at least one beta-bonded di-glucose. Also disclosed are methods to make and/or use such mixtures.

27 Claims, 6 Drawing Sheets