ABSTRACT

Coconut sap is the sweet translucent substance that is derived by tapping coconut inflorescence and is commonly used as raw material of coconut sugar. The chemical properties of coconut sap are influenced by tapping condition. Reducing sugar and amino acid on coconut sap are important properties in non-enzymatic reaction, i.e. Maillard reaction which will generate distinctivebrown color and flavor of the coconut sugar produced. The polar amino acid with the positively charged end such as arginine and histidine makes it suitable for binding carbonyl groups of reducing sugars. This interaction is called carbonylamino reaction, the initial stage of Maillard reaction. This research aimed (1) to determine the effect of weather as well as variations of the concentration of mangosteen peel powder and tapping time on the characteristics of coconut sap, and obtain the chemical characteristics of coconut sap that can be used to produce granulated coconut sugar, (2) to determine changes in chemical characteristics and antioxidant properties of coconut sap during preheating as an indicator of the occurrence of the Maillard reaction, (3) to evaluate the effects of arginine and histidine on chemical and antioxidant properties of Maillard reaction products (MRPs) and melanoidin formed during heating process of coconut sap and (4) to evaluate the efficacy of melanoidin fractions of granulated coconut sugar as antioxidant compounds. The research was conducted in four stages, i.e. stage I: Chemical characterization of tapping coconut sap, stage II: Verification of the Maillard reaction during heating of coconut nira into ant sugar, stage III: Chemical characterization and antioxidant MRPs and melanoidin during heating of coconut sap with addition of arginine and histidine and stage IV: Isolation and fractionation of granulated coconut sugar melanoidin based on molecular weight. Coconut sap that was suitable to produce granulated sugar was obtained during daytime with preservative addition of a mixture of 1.7 g/L lime and 0.56 g/L mangosteen peel powder. The chemical properties of such coconut sap were as follows: the pH value was higher than 6.6, total soluble solid was not less than 15.1 ºbrix, water content was less than 88.84 %, reducing sugar was less than 0.48 g/100g and sucrose content was higher than 10.17 g/100g. The decrease of reducing sugar and free amino acid in coconut sap at the initial heating indicated the occurring of carbonyl-amino reaction. The radical scavenging activity increased when the heating time reached 50 min. In the meanwhile, the chelating activity of coconut sap increased at the beginning of 20 to 40 min of heating. Addition of arginine and histidine could maintain the alkaline pH of coconut sap during heating. Maillard reaction generated through 2,3-enolization pathway produced reductone compound as antioxidant. The addition of arginine produced MRPs in coconut sap during heating which increased radical scavenging activity (RSA), while the addition of histidine produced MRPs that increased chelating activity, but did not increase RSA and chelating activity in the produced granulated coconut sugar. The addition of arginine to coconut sap effectively increased the ability to inhibit lipid peroxidation of granulated coconut sugar. RSA and chelating activity of sugar produced from the sap with the addition of arginine were caused by the melanoidin fraction of 14-50 kDa. The fraction of

<14 kDa (non melanoidin) of sugar produced from coconut sap with the addition of arginine was effective for inhibiting lipid peroxidation evaluated by the FTC method. Fraction> 50 kDa of sugar produced from sap with the addition of histidine played a role in capturing free radicals and inhibiting lipid peroxidation evaluated by the FTC method. It can be concluded that Maillard reaction occured during the heating of coconut sap in the granulated sugar production process. The occurrence of Maillard reaction was indicated by the formation of reductons and melanoidin which had antioxidant activity. Addition of arginine to coconut sap prior to heating produced granulated sugar which could inhibit lipid peroxidation effectively.

Keywords: arginine, antioxidant activity, coconut sap, histidine, Maillard reaction

INTISARI

Nira kelapa adalah cairan yang diperoleh dari penyadapan *inflorescense* pohon kelapa dan dapat diolah menjadi gula semut. Sifat-sifat kimia nira kelapa dipengaruhi oleh kondisi penyadapan. Gula reduksi dan asam amino bebas pada nira kelapa berperan dalam reaksi pencokelatan non-enzimatis yaitu reaksi Maillard yang menghasilkan warna cokelat dan *flavor* pada gula semut. Asam amino polar dengan rantai samping bermuatan positif yaitu arginin dan histidin dapat mengikat gugus karbonil gula reduksi. Reaksi ini disebut reaksi karbonil-amino yang merupakan tahap awal reaksi Maillard. Penelitian ini bertujuan (1) mengetahui pengaruh cuaca, variasi konsentrasi bubuk kulit manggis dan waktu penyadapan terhadap karakteristik nira kelapa, serta mendapatkan karakteristik kimia nira kelapa yang dapat digunakan untuk pengolahan gula semut, (2) mengetahui perubahan karakteristik kimia dan sifat antioksidatif nira kelapa selama pemanasan awal sebagai indikator terjadinya reaksi Maillard, (3) mengetahui perubahan karakteristik dan sifat antioksidatif nira kelapa yang ditambah asam amino arginin dan histidin selama pemanasan, (4) mengetahui efektifitas MRPs dan fraksi-fraksi melanoidin gula semut sebagai antioksidan. Penelitian dilakukan dalam empat tahap meliputi tahap I: Karakterisasi kimia nira kelapa hasil sadap, tahap II: Verifikasi reaksi Maillard selama pemanasan nira kelapa menjadi gula semut, tahap III: Karakterisasi kimia dan antioksidan MRPs dan melanoidin selama pemanasan nira kelapa dengan penambahan arginin dan histidin dan tahap IV: Isolasi dan fraksinasi melanoidin gula semut berdasar berat molekul. Hasil penelitian menunjukkan bahwa nira kelapa yang dapat diolah menjadi gula semut memiliki pH minimum 6,6; total padatan terlarut minimum 15,1 ºbrix; kadar air maksimum 88,84%; gula reduksi maksimum 0,48 g/100 g dan sukrosa minimum 10,17 g/100 g. Karakteristik nira tersebut diperoleh melalui penyadapan cuaca cerah, selama siang hari (9 jam) dan menggunakan pengawet campuran 1,7 g/L bubuk kapur dan 0,56 g/L bubuk kulit manggis. Penurunan gula reduksi dan asam amino bebas nira kelapa pada pemanasan awal menunjukkan terjadinya reaksi karbonil-amino. Aktivitas menangkap radikal bebas nira kelapa menurun hingga pemanasan 50 menit, sedangkan *chelating activity* meningkat pada pemanasan 20 hingga 40 menit. Penambahan arginin dan histidin dapat mempertahankan pH nira alkali sehingga reaksi Maillard diduga terjadi melalui jalur 2,3-enolisasi menghasilkan redukton yang berpotensi sebagai antioksidan. Penambahan arginin menghasilkan MRPs pada nira kelapa selama pemanasan yang meningkatkan *radical scavenging activity* (RSA), sedangkan penambahan histidin menghasilkan MRPs yang meningkatkan *chelating activity*, namun tidak meningkatkan RSA dan *chelating activity* pada gula semut yang dihasilkan. Penambahan arginin pada nira kelapa efektif meningkatkan kemampuan menghambat peroksidasi lipid gula semut. RSA dan *chelating activity* gula yang dihasilkan dari nira dengan penambahan arginin disebabkan oleh fraksi melanoidin 14-50 kDa. Fraksi<14 kDa (non melanoidin) gula yang dihasilkan dari nira kelapa dengan penambahan arginin efektif untuk menghambat peroksidasi lipid yang dievaluasi dengan metode FTC. Fraksi>50 kDa gula yang dihasilkan dari nira dengan penambahan histidin berperan menangkap

radikal bebas dan menghambat peroksidasi lipid yang dievaluasi dengan metode FTC. Kesimpulan penelitian ini adalah selama pemanasan nira kelapa menjadi gula semut terjadi reaksi Maillard yang diindikasikan oleh terbentuknya redukton dan melanoidin yang memiliki aktivitas antioksidan. Penambahan arginin pada nira kelapa sebelum pemanasan menghasilkan gula semut yang efektif menghambat peroksidasi lipid.

Kata kunci: arginin, aktivitas antioksidan, getah kelapa, histidin, reaksi Maillard