Pengembangan Kefir Susu Kambing dengan Penambahan *Oat Milk* dan *Lacticaseibacillus casei* AP sebagai Pangan Fungsional Anti Obesitas

INTISARI

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Kefir merupakan produk susu fermentasi yang mengandung bakteri asam laktat dan *yeast*, sedangkan *oat milk* diketahui mengandung prebiotik. Sementara itu *Lacticaseibacillus casei* AP sudah terbukti merupakan probiotik. Tujuan umum penelitian ini untuk mengembangkan kefir susu kambing dengan penambahan *oat milk* dan *Lacticaseibacillus casei AP* sebagai pangan fungsional anti obesitas. Penelitian ini dibagi menjadi tiga tahapan yaitu: 1. Optimasi persentase penambahan *oat milk* dan *Lacticaseibacillus casei* AP pada pembuatan kefir susu kambing; 2. Karakterisasi kefir susu kambing dengan penambahan *oat milk* dan/atau *Lacticaseibacillus casei* AP selama penyimpanan; 3. Karakterisasi kefir susu kambing dengan penambahan *oat milk* dan *Lacticaseibacillus casei* AP sebagai anti obesitas pada tikus yang diinduksi pakan tinggi lemak. Penelitian tahap 1 dilakukan dengan metode eksperimental menggunakan Rancangan Acak Lengkap (RAL) Faktorial 3x2. Faktor A yaitu persentase penambahan *oat milk* (8%, 12% dan 16%) dan Faktor B adalah persentase penambahan *Lacticaseibacillus casei* AP (2% dan 4%) dilakukan pengulangan sebanyak 4 kali pada setiap perlakuan. Parameter yang diamati meliputi: kualitas fisikokimia (viskositas, sineresis, keasaman, pH, alkohol, analisis proksimat), kualitas mikrobiologis (total BAL, TPC, total probiotik dan total yeast), dan kualitas sensoris (warna, aroma, keasaman, tekstur, rasa alkoholis, dan *overall*). Hasil penelitian tahap 1 menunjukkan bahwa penambahan 16% (b/b) *oat milk* dan 4% (b/b) *Lacticaseibacillus casei* AP mampu meningkatkan total padatan, viskositas dan kualitas sensoris, tetapi tidak mengubah karakteristik fisikokimia dan mikrobiologis. Persentase penambahan 16% (b/b) *oat milk* dan 4% (b/b) *Lacticaseibacillus casei* AP kemudian diaplikasikan pada penelitian tahap 2. Penelitian tahap 2 terdiri dari 4 perlakuan: P1 (Kefir susu kambing); P2 (Kefir susu kambing + 4% (b/b) *Lacticaseibacillus casei* AP); P3 (Kefir susu kambing + 16% (b/b) *oat milk*); P4 (Kefir susu kambing + 16% (b/b) *oat milk* + 4% (b/b) *Lacticaseibacillus casei* AP). Parameter yang dianalisis meliputi kualitas fisikokimia (viskositas dan sineresis, keasaman, pH, alkohol, analisis proksimat, *free fatty acid*/FFA, profil asam lemak, profil asam amino), kualitas mikrobiologis (total BAL, total bakteri, total probiotik, total *yeast*), dan kualitas sensoris. Evaluasi karakteristik kefir dilakukan selama penyimpanan 0; 7 dan 14 hari yang disimpan pada suhu 4^{o}C, dengan replikasi 3 kali. Hasil penelitian tahap 2 menunjukkan kualitas produk kefir dengan 16% (b/b) o*at milk* dan 4% (b/b) *Lacticaseibacillus casei* AP hingga akhir masa simpan (14 hari) lebih baik dibandingkan dengan penambahan 16% (v/v) o*at milk* (prebiotik) atau 4% (b/b) *Lacticaseibacillus casei* AP (probiotik) secara terpisah. Kefir susu kambing dengan penambahan 16% (b/b) *oat milk* dan 4% (b/b) *Lacticaseibacillus casei* AP, yang selanjutnya akan disebut kefir sinbiotik (KS) kemudian diuji secara pra klinis menggunakan hewan uji tikus *Sprague Dawley* yang diinduksi pakan tinggi lemak (*high fat diet;* HFD). Penelitian tahap 3 dilakukan selama 5 minggu, satu minggu pertama merupakan tahap adaptasi pakan. Kemudian masuk ke tahap induksi dimana selain diberi pakan standar juga

diberi HFD selama 2 minggu secara oral, terkecuali 6 ekor tikus tetap hanya diberi pakan standar yang dikelompokkan sebagai kelompok kontrol normal/tikus sehat. Tahap selanjutnya merupakan tahap pemberian perlakuan dilakukan selama 2 minggu. Pada tahapan ini terdapat 4 perlakuan dengan rincian sebagai berikut: **KN (Kontrol Normal):** tikus yang diberi pakan standar, **OB (Obes):** tikus yang diberi pakan standar+HFD, **OB+K (Obes + Kefir):** tikus yang diberi pakan standar+HFD, ditambah produk kefir sebanyak 3,6 ml/200 g BB/ hari diberikan secara oral, **OB+KS (Obes + Kefir Sinbiotik):** tikus yang diberi pakan standar+HFD ditambah produk KS sebanyak 3,6 ml/200 g BB/ hari diberikan secara oral. Parameter yang diamati meliputi: konsumsi pakan, berat badan tikus, profil lipid darah, profil mikrobiota, SCFA, ekspresi gen *FFAR2, FFAR3* dan leptin di adiposa putih, dan kadar sitokin proinflamasi (TNF-α) pada sirkulasi (darah). Hasil penelitian tahap 3 menunjukkan bahwa konsumsi kefir susu kambing dengan penambahan 16% (b/b) *oat milk* dan 4% (b/b) *Lacticaseibacillus casei* AP dapat digunakan sebagai pangan fungsional anti obesitas melalui penghambatan peningkatan bobot badan, konsumsi pakan, dan trigliserida, peningkatan HDL, penurunan kadar TNF-α, serta memperbaiki keragaman mikrobiota usus. Dapat disimpulkan bahwa konsumsi kefir susu kambing dengan penambahan *oat milk* (4% b/b) dan *Lacticaseibacillus casei* AP (16% b/b) dapat berperan sebagai pangan fungsional anti obesitas pada tikus yang diinduksi pakan tinggi lemak.

Kata kunci: Kefir Susu Kambing, *Lacticaseibacillus casei* AP, Oat milk, Obesitas, dan Pangan Fungsional.

Development of Goat milk kefir with additions of Oat Milk and *Lacticaseibacillus casei* AP as Anti-Obesity Functional Food

ABSTRACT

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While oat milk is known to contain prebiotics, kefir is a fermented milk product that contains yeast and lactic acid bacteria, and *Lacticaseibacillus casei AP* is a true probiotic. This study primarily aims to develop goat milk kefir incorporated with oat milk and *Lacticaseibacillus casei AP* milk as a functional anti-obesity food. The present investigation was structured into three distinct phases. Firstly, the percentage of oat milk and *Lacticaseibacillus casei AP* addition in the production of goat milk kefir was optimized. Secondly, the kefir was characterized in storage with the addition of oat milk, *Lacticaseibacillus casei AP*, or both. Lastly, the kefir was characterized in relation to its anti-obesity properties in rats induced by high-fat diet. This initial phase was carried out experimentally with a 3x2 Factorial Completely Randomized Design (CRD),. Factor A was the percentage of oat milk addition (8%, 12%, and 16%), and Factor B was the percentage of *Lacticaseibacillus casei AP* addition (2% and 4%) with four replicates. The observed parameters were physicochemical quality (viscosity, syneresis, acidity, pH, alcohol, proximate analysis), microbiological quality (total LAB, TPC, total probiotics and total yeast), and organoleptic quality (color, aroma, acidity, texture, alcoholic taste, and the overall quality). The results of phase 1 showed that the addition of 16% (w/w) *oat milk* and 4% (w/w) *Lacticaseibacillus casei AP* can increase total solids, viscosity, and organoleptic quality, but did not convert the physicochemical and microbiological characteristics. The addition of 16% (w/w) *oat milk* and 4% (w/w) *Lacticaseibacillus casei AP* was subsequently applied to four treatments in phase 2: P1 (goat milk kefir), P2 (goat milk kefir + 4% (w/w) *Lacticaseibacillus casei AP*), P3 (goat milk kefir + 16% (v/v) *oat milk*), and P4 (goat milk kefir + 16% (w/w) *oat milk* + 4% (w/w) *Lacticaseibacillus casei AP*). The analyzed parameters were physicochemical quality (viscosity and syneresis, acidity, pH, alcohol, proximate analysis, free fatty acid/FFA, fatty acid profile, amino acid profile), microbiological quality (total LAB, total bacteria, total probiotics, total yeast), and organoleptic quality. The kefir was stored at 4°C and analyzed on storage 0, 7, and 14, with 3 replicates. The results of phase 2 demonstrated that the quality of kefir products with 16% (w/w) oat milk and 4% (w/w) *Lacticaseibacillus casei AP* until the end of the shelf life (14 days) was better than kefir added with 16% (w/w) oat milk (prebiotic) or 4% (w/w) *Lacticaseibacillus casei AP* (probiotic) separately. Goat milk kefir added with 16% (w/w) oat milk and 4% (w/w) *Lacticaseibacillus casei AP*, called the synbiotic kefir (KS), was subject to a pre-clinical test to Sprague Dawley rats induced by high fat diet (HFD) for phase 3. Phase 3 was conducted for 5 weeks, started with one-week feeding adaptation using basal feed, followed by two-week induction stage using basal feed + HFD orally, except for 6 rats separated as the control group fed on basal feed. The last two weeks was the treatment stage where rats were alloted to four groups: KN (Normal Control): basal feed; OB (Obes): basal feed + HFD; OB + K (Obese + Kefir): basal feed + HFD + orally-administered kefir 3.6 ml/200 g BW/day; and OB + KS (Obes + Kefir

Synbiotic): basal feed + HFD + orally-administed KS (Kefir synbiotic) by 3.6 ml/200 g BW/day. The observed parameters were feed consumption; body weight; blood lipid profile; cecum metagenomics; SCFA, FFAR2, FFAR3 and leptin gene expression in white adipose; and proinflammatory cytokine levels (TNF-α) in circulation (blood). The results of phase 3 showed that consumption of goat milk kefir incorporated with 16% (w/w) oat milk and 4% (w/w) *Lacticaseibacillus casei AP* was feasible as functional anti-obesity food as it inhibited body weight gain, feed consumption, and triglycerides, increased HDL, decreased TNF-α levels, and improved the diversity of intestinal microbiota. Conclusively, the consumption of goat milk kefir added with oat milk (4%w/w) and *Lacticaseibacillus casei AP* (16% w/w) is a viable anti-obesity drink in rats induced by high-fat feed.

Key words: Goat milk kefir, *Lacticaseibacillus casei AP*, Oat milk, Obesity, and Functional Food