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Development of skincare cosmetic from yeast beta-glucans

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Objectives: This study aimed to will create value to the industrial waste by systematic extraction and purification of beta-glucan from by-product of yeast (*Saccharomyces cerevisiae*) and develop skincare cosmetic from beta-glucan extract.
Methods: Beta-glucan from by-product of yeast (*Saccharomyces cerevisiae*) obtained from beer industry was involved treatments with cell lysis fractioning, solvent extraction and freeze drying. Then the extract was identified beta-(1,3)-(1,6)-glucan by TLC and UV-visible spectroscopy. The amount of beta-glucan in the extract was measured by HPLC. Its antioxidant activity with nitric oxide and DPPH radical scavenging assay were investigated. The extract was formulated as an oil-in-water emulsion in 3 formulations with cold process and the formulations were selected on the best physical and chemical properties after accelerated stability tests. Then, the measurement of the skin humidity was performed in 15 female volunteers by using moisture sensor after application of the sample for 2 weeks.
Results: The results showed that beta-glucan was the major active ingredient in the extract and the percent yield of extraction was 70.03%w/w. The concentration of beta-glucan for inhibiting nitric oxide radical and DPPH 50% were 92.95 and 88.74 µg/ml, respectively. The protective effect against the skin humidity reduction depended on the beta-glucan concentration. The volunteers were very satisfied in moderate to good level and average moisture contents of the skin before and after applying 5% beta-glucan cream were 42.8% and 49.0%, respectively ($p<0.05$). No irritation on 5% beta-glucan cream was found. The stability test of formulated cream by heating and cooling of 6 cycles was found that all tested products were still stable with more viscous and pale color.
Conclusion: The results obtained in this study showed that beta-glucan extract from yeast waste contains beneficial cosmeceutical properties including antioxidant, moisture retention and skin regeneration. It had a promising potential for use as an effective and economical cosmetic ingredient that can be applied in skincare especially for sensitive skin.

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Introduction

Saccharomyces cerevisiae is one of the most common species of yeast used in baker, brewer, and energy industry[1-2]. The yeasts are used during these productions becomes by-process waste. Beta–glucan is D-glucose polysaccharide molecule comprised of repeating glucose units[3]. Beta-glucan contains beneficial cosmeceutical properties including skin regeneration, moisture retention, antioxidant, anti-aging, restoration of skin injury and radio protective effects[4-6]. This study will create value to the industrial waste in term of cost cutting of waste treatment by systematic extraction and purification of beta-glucan from by-product of yeast (*Saccharomyces cerevisiae*) and develop skincare cosmetic from beta-glucan extract.

Methods

Isolation processes of beta-glucan from by-product of yeast (*Saccharomyces cerevisiae*) were obtained from beer industry. The yeast waste from beer fermentation was involved treatments with hot alkali for 5 hrs to remove the manoprotein. The broken cells were separated using a centrifuge at 10,000 rpm for 10 min at 4^0C, added with ethanol, then the mixture was left to stand 24 hrs for precipitation. The washed sediment was treated with an excess of acetone and filtered for removal the lipids. The residue was dried at 70^0C under vacuum, yielding beta-glucan as a pale yellow powder effects[7-8]. Then the extract was identified beta-(1,3)-(1,6)-glucan by TLC and UV-visible spectroscopy. The amount of beta-glucan in the extract was measured by HPLC[8]. The *in vitro* physical-antioxidant activity with nitric oxide and DPPH radical scavenging assay were investigated[9]. Then the extract was formulated as an oil-in-water emulsion in 3 formulations with cold process. The formulated creams were tested for the physicochemical parameters such as colour, odour, pH and viscosity. Stability study was done by heating and cooling method. Viscosity of the cream was measured using a Brookfield viscometer at 10-50 rpm at 25°C. The formulation with the best physical and chemical properties was selected after accelerated stability test. The study protocol in volunteers was approved by the Research Ethics Committee of Faculty of Pharmacy, Chiang Mai University. The emulsion formulation of beta-glucan at various concentrations (1, 3 and 5%w/w) was used as a pretreatment on 15 volunteers' forearms for evaluation of skin humidity

protective effects caused by a challenge with 10% sodium dodecyl sulfate for 2 hr over a period of 2 weeks. To ensure cream free from adverse effects, a sensitivity study using patch test for irritancy was done. The closed patch test with 5% beta-glucan cream was conducted on the forearms of 15 healthy volunteers in 24-hr and 3-days observations. Then, further evaluated formulations in 15 female volunteers, the subjects were daily applied on each her arm blindly with 1, 3, 5%w/w testing cream compared to cream base using a parallel clinical trial with self-control applied cream. The volunteers were assessed the satisfaction of using cream after 2 weeks. The value of % moisture was measured on each application site of each arm every week using moisture sensor and then compared relatively to the initial treated arms within the same subject using paired t-test (alpha = 0.05).

Results

Beta-glucan is D-glucose polysaccharide molecule linked by beta glycoside bonds (Figure 1). Schematic diagram shows the extraction and purification of glucan from yeast (Figure 2). The results showed beta-glucan was the major active ingredient in the extract and the percent yield of extraction was 70.03%w/w. Figures 3 and 4 showed the antioxidant activity of beta-glucan was increased proportional to the concentration of beta-glucan (dose dependent). The concentration of beta-glucan for inhibiting nitric oxide radical and DPPH 50% were 92.95 and 88.74 µg/ml, respectively. The o/w cream formulations of beta-glucan at different concentrations (1, 3, 5 %w/w) were used as a pretreatment on 15 volunteers' forearms for evaluation of skin humidity protective effects caused by a challenge with 10% sodium dodecyl sulfate over a period of 2 weeks. All formulations enhanced the skin humidity compared with the untreated skin. The protective effect against the skin humidity reduction depended on the beta-glucan concentration. At a concentration of 5% beta-glucan, the result indicated that this formulation enhanced the skin humidity compared to the untreated skin obviously. The viscosity of the 5% beta-glucan formulation was tested by Brookfield Rheometer showed good spreadability with 3871.64±103.79 mPas. The volunteers were very satisfied and average moisture of the skin before and after applying 5% beta-glucan cream were 42.8% and 49.0%, respectively. No primary irritation due to 5% beta-glucan cream was observed in 15 human subjects in a closed patch test after 24 hr and 3 days. The stability test of formulated cream by heating and cooling of 6 cycles was found that all tested creams were still stable with more viscous and pale color. The beta-glucan was the most effective agent giving the short onset of significant nourishing effect after only day 14 of application ($p<0.05$).

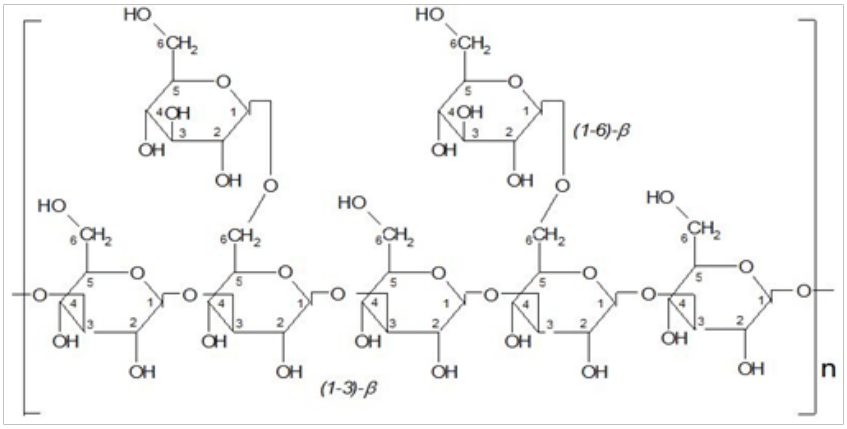

Figure 1. Structure of yeast beta glucan.

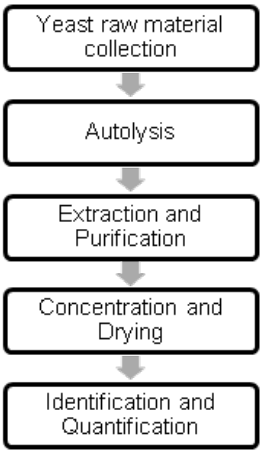

Figure 2. Schematic diagram showing the extraction and purification of glucan from yeast.

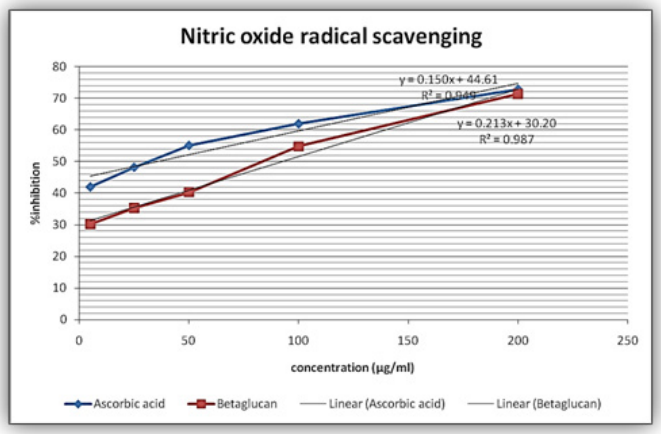

Figure 3. Free radical scavenging effects of beta-glucan measured by nitric oxide assay.

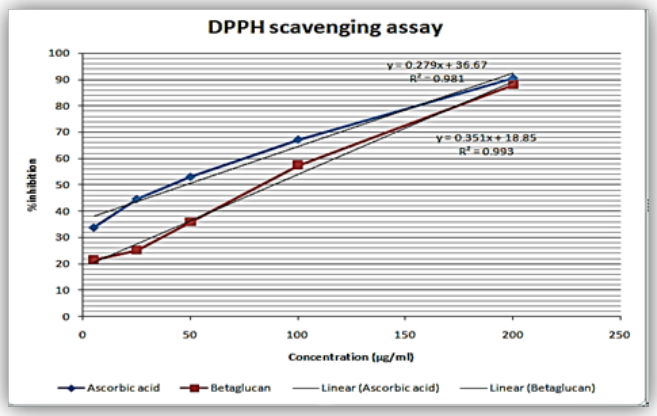

Figure 4. Free radical scavenging effects of beta-glucan measured by DPPH assay.

Discussion

Beta-glucan–D-glucose polymers is major structural component in cell wall not only for microorganisms such as yeast, bacteria, and fungi but also in mushrooms and cereals. *Saccharomyces cerevisiae* is the most used yeast for the beta-glucan extraction industry[2]. The composition of *S. cerevisiae* beta-glucan comprises of approximately 85% of β-1,3 glucan and 3% of β-1,6 glucan[10]. The new method invested by Lui *et al.* (2008) has advantages in term of higher yields and purity of beta-D-glucans, preservation of the original conformation, and relatively more environmentally friendly compared to the traditional solvent extraction[8]. However, the proposed isolation method requires excessive isolation steps with organic solvent and protease hydrolysis which might not be cost effective in the industrial scale. Yeast extract also contains plenty of amino acids, peptides and nucleic acids[5]. Amino acids and nucleic acids can be easily absorbed by skin and nourish the skin cells. Consequently, yeast extract can promote collagen synthesis, acts as an anti-inflammatory, moisturize and revitalize the skin[4]. Beta-glucan can be used as a cosmetic ingredient because of its protective effect against oxidative stress induces by the UVA radiation, its anti-wrinkle efficacy in addition to its nourishing effect. This study will not only advance our knowledge concerning the values of yeast glucan in applicable cosmetic usages, but also build understanding in value creation of waste product that will create the foundation of zero-waste concept in future studies.

Conclusion

This study showed that beta-glucan extract contains beneficial cosmeceutical properties including antioxidant, moisture retention and skin regeneration, have a promising potential for use as an effective and economical cosmetic that can be applied in skincare especially for sensitive skin.

Acknowledgements

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