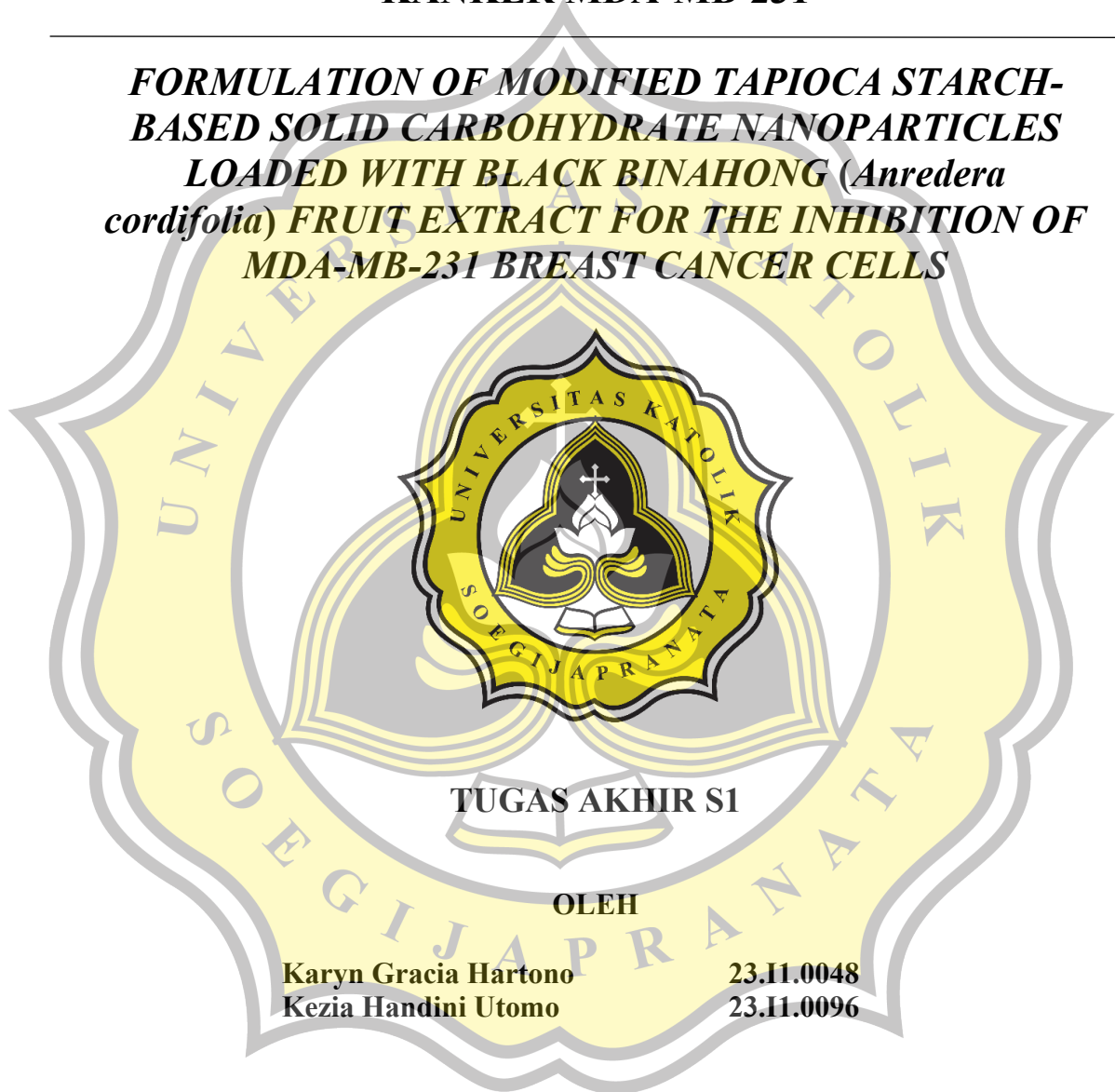


**FORMULASI *SOLID CARBOHYDRATE*
NANOPARTICLES EKSTRAK BUAH BINAHONG
HITAM (*Anredera cordifolia*) BERBASIS MATRIKS
MODIFIED TAPIOCA STARCH DALAM INHIBISI SEL
KANKER MDA-MB-231**

***FORMULATION OF MODIFIED TAPIOCA STARCH-
BASED SOLID CARBOHYDRATE NANOPARTICLES
LOADED WITH BLACK BINAHONG (*Anredera
cordifolia*) FRUIT EXTRACT FOR THE INHIBITION OF
MDA-MB-231 BREAST CANCER CELLS***



TUGAS AKHIR S1

OLEH

**Karyn Gracia Hartono
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**23.11.0048
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**PROGRAM STUDI SARJANA TEKNOLOGI PANGAN
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TUGAS AKHIR S1

Diajukan untuk
memenuhi persyaratan yang diperlukan untuk
memperoleh gelar Sarjana Teknologi Pangan

OLEH

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RINGKASAN

Kanker payudara merupakan salah satu penyebab utama kematian akibat kanker pada perempuan di dunia, dengan sel MDA-MB-231 sebagai model *Triple-Negative Breast Cancer* (TNBC) yang tidak responsif terhadap terapi hormonal maupun target HER2 sehingga pilihan pengobatannya terbatas. Kemoterapi konvensional berisiko menimbulkan efek samping yang menurunkan kualitas hidup pasien, sehingga pengembangan terapi alternatif berbasis bahan alami menjadi penting. Binahong hitam (*Anredera cordifolia*) mengandung senyawa bioaktif seperti saponin, triterpenoid, alkaloid, polifenol, dan flavonoid yang berpotensi sebagai agen antikanker, namun pemanfaatannya sebagai pangan fungsional terkendala oleh bioavailabilitas dan stabilitas senyawa yang rendah. Nanoteknologi berbasis *Solid Carbohydrate Nanoparticles* (SCNP) menggunakan matriks *modified tapioca starch* dipilih sebagai strategi untuk mengatasi keterbatasan tersebut, karena mampu memberikan stabilitas fisik-kimia dan efisiensi enkapsulasi yang lebih baik dibandingkan nanopartikel cair. Penelitian ini bertujuan untuk mengetahui pengaruh variasi konsentrasi ekstrak binahong hitam dan komposisi inti matriks terhadap karakteristik fisik dan kimia, serta aktivitas sitotoksitas terhadap sel MDA-MB-231 pada SCNP yang dihasilkan. Metode meliputi ekstraksi *ultrasonic-assisted*, sintesis SCNP dengan total konsentrasi *carrier* 10%, pengeringan menggunakan *spray dryer* (suhu *inlet* 150°C, *outlet* 90°C), serta karakterisasi menggunakan, uji DPPH, Folin-Ciocalteu, AlCl₃, X-ray *Diffraction* (XRD), *Scanning Electron Microscopy* (SEM), dan *Fourier Transform Infrared Spectroscopy* (FTIR). Sintesis SCNP dilakukan dengan menggunakan variasi konsentrasi ekstrak buah binahong hitam, yaitu 5% dan 10%. Sementara itu, konsentrasi *modified tapioca starch* sebagai bahan *carrier* dalam 10% inti matriks, yaitu 100%, 70%, 30%. Hasil penelitian menunjukkan seluruh enam formulasi (AMSK 5, AMSMD 735, AMSMD 555, AMSK 10, AMSMD 7310, AMSMD 5510) menghasilkan ukuran partikel berskala nano, yaitu 33,457–240,800 nm, dengan nilai PDI 0,467–0,855. Peningkatan konsentrasi ekstrak dari 5% menjadi 10% secara konsisten menurunkan ukuran partikel pada seluruh komposisi matriks, diduga akibat interaksi ikatan hidrogen antara gugus hidroksil polifenol binahong dan rantai pati yang menurunkan viskositas larutan sebelum atomisasi. Penambahan maltodekstrin juga memperkecil ukuran partikel dibandingkan penggunaan *modified tapioca starch* tunggal, meskipun tidak selalu meningkatkan homogenitas distribusi ukuran. Aktivitas antioksidan dan kadar fenolik tertinggi diperoleh pada formulasi AMSK 5 (72,457% inhibisi; 236,300 mg/100 g), sedangkan proporsi maltodekstrin yang lebih tinggi cenderung menurunkan aktivitas antioksidan akibat efek pengenceran. Analisis XRD menunjukkan seluruh sampel bersifat *highly amorphous* (67,6–70,6%), mengindikasikan gangguan keteraturan struktur kristalin pati akibat interaksi dengan polifenol selama enkapsulasi. Pengamatan SEM memperlihatkan partikel berbentuk sferis dengan permukaan berkerut khas produk *spray drying*, dengan maltodekstrin mendukung pembentukan partikel yang lebih seragam. Analisis FTIR mengonfirmasi keberhasilan enkapsulasi senyawa fenolik/flavonoid binahong hitam di dalam matriks pati, ditandai oleh pita serapan

gugus O–H, C–O, dan ikatan glikosidik α -1,4/ α -1,6 yang konsisten pada seluruh sampel.



SUMMARY

Breast cancer is one of the leading causes of cancer-related deaths among women worldwide, with the MDA-MB-231 cell line serving as a model for Triple-Negative Breast Cancer, a subtype that does not respond to hormonal therapy or HER2-targeted treatment, resulting in limited therapeutic options. Conventional chemotherapy carries the risk of side effects that reduce patients' quality of life, making the development of alternative therapies based on natural compounds important. Black binahong (*Anredera cordifolia*) contains bioactive compounds such as saponins, triterpenoids, alkaloids, polyphenols, and flavonoids that have potential as anticancer agents. However, their application as functional food ingredients is hindered by low bioavailability and stability. Nanotechnology based on Solid Carbohydrate Nanoparticles using a modified tapioca starch matrix was selected as a strategy to overcome these limitations, as it offers better physicochemical stability and encapsulation efficiency compared to liquid nanoparticle systems. This study aimed to determine the effect of variations in black binahong extract concentration and matrix core composition on the physical characteristics, chemical characteristics, and cytotoxic activity of the synthesized Solid Carbohydrate Nanoparticles (SCNPs) against MDA-MB-231 breast cancer cells. The methods included ultrasonic-assisted extraction, SCNP synthesis with a total carrier concentration of 10%, spray drying (inlet temperature: 150°C; outlet temperature: 90°C), and characterization through particle size and polydispersity index (PDI) measurements, DPPH radical scavenging assay, Folin–Ciocalteu assay, aluminum chloride (AlCl₃) assay, X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), and Fourier Transform Infrared Spectroscopy (FTIR). SCNPs were synthesized using two concentrations of black binahong (*Anredera cordifolia*) fruit extract (5% and 10%). The carrier matrix was maintained at a total concentration of 10% and consisted of modified tapioca starch at proportions of 100%, 70%, or 30%, with the remaining proportion replaced by maltodextrin. The results showed that all six formulations (AMSK 5, AMSMD 735, AMSMD 555, AMSK 10, AMSMD 7310, AMSMD 5510) produced particles at the nanoscale, ranging from 33.457 to 240.800 nm, with PDI values of 0.467–0.855. Increasing the extract concentration from 5% to 10% consistently decreased particle size across all matrix compositions, presumably due to hydrogen bonding interactions between the hydroxyl groups of binahong polyphenols and starch chains, which reduced solution viscosity prior to atomization. The addition of maltodextrin also reduced particle size compared to the use of modified tapioca starch alone, although it did not always improve size distribution homogeneity. The highest antioxidant activity and phenolic content were obtained for the AMSK 5 formulation, at 72.457% inhibition and 236.300 mg/100 g respectively, while a higher proportion of maltodextrin tended to decrease antioxidant activity due to a dilution effect. XRD analysis revealed that all samples were highly amorphous, with amorphous content of 67.6–70.6%, indicating disruption of the ordered crystalline structure of starch caused by interaction with polyphenols during encapsulation.

SEM observations showed spherical particles with wrinkled surfaces characteristic of spray-dried products, with maltodextrin promoting the formation of more uniform particles. FTIR analysis confirmed the successful encapsulation of black binahong phenolic/flavonoid compounds within the starch matrix, indicated by consistent absorption bands corresponding to O–H, C–O, and α -1,4/ α -1,6 glycosidic bonds across all samples.

