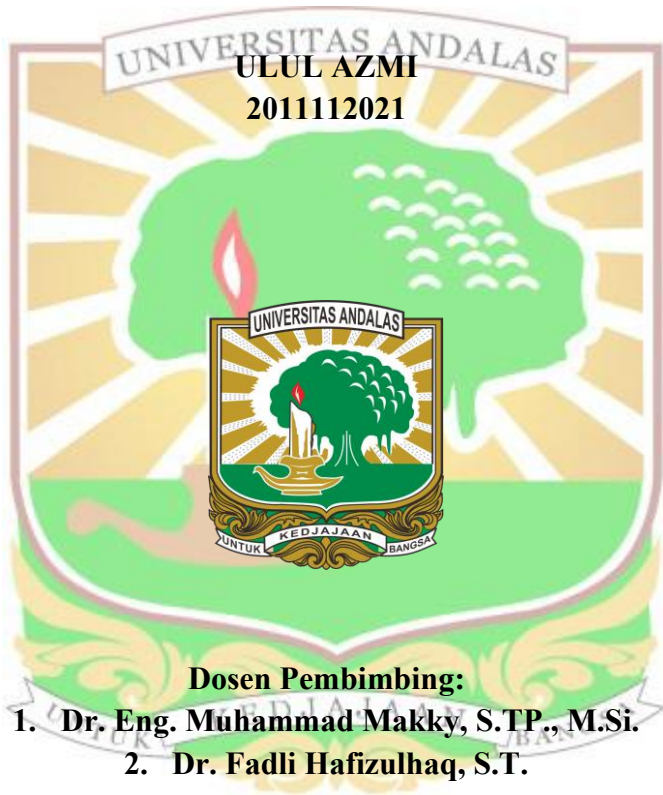


**PENGEMBANGAN SISTEM *MONITORING*
MASSA PADA PENGERINGAN PISANG SALE
BERBASIS MIKROKONTROLER ESP32**



**FAKULTAS TEKNOLOGI PERTANIAN
UNIVERSITAS ANDALAS
PADANG
2026**

PENGEMBANGAN SISTEM *MONITORING* MASSA PADA PENGERINGAN PISANG SALE BERBASIS MIKROKONTROLER ESP32

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ABSTRAK

Proses pengeringan pisang sale memerlukan pemantauan massa secara berkala, namun penimbangan manual mengharuskan bahan dikeluarkan dari oven sehingga dapat mengganggu kondisi pengeringan dan meningkatkan risiko kesalahan pengukuran. Penelitian ini bertujuan mengembangkan sistem *monitoring* massa berbasis mikrokontroler ESP32 yang memantau perubahan massa sebagai parameter utama, serta suhu dan kelembapan relatif (RH) sebagai parameter pendukung selama pengeringan pisang sale. Sistem menggunakan sensor *load cell* dengan modul HX711 sebagai pengukur massa, sensor SHT31 sebagai pemantau suhu dan RH, serta ESP32 sebagai pengolah dan pengirim data ke Google Sheets melalui jaringan internet. Pengujian meliputi kalibrasi dan validasi sensor, pengujian penyimpanan data, serta pengamatan selama pengeringan pada tiga perlakuan suhu. Hasil kalibrasi *load cell* menunjukkan hubungan linier yang sangat baik dengan koefisien determinasi (R^2) sebesar 0,99997. Hasil validasi menunjukkan rata-rata galat pembacaan massa sebesar 0,1%, suhu 3,29%, dan RH 4,13%. Sistem berhasil memantau massa selama pengeringan, meskipun kontinuitas pencatatan data pada beberapa pengujian terganggu akibat pemadaman listrik dan gangguan koneksi internet. Analisis energi menunjukkan estimasi konsumsi energi listrik sebesar 3,68–5,05 kWh dengan efisiensi pengeringan 1,50–2,16%. Hasil penelitian menunjukkan sistem yang dikembangkan mampu memantau massa selama pengeringan serta menyediakan data perubahan massa sebagai parameter utama, dan data suhu serta RH sebagai informasi pendukung dalam menggambarkan kondisi proses pengeringan.

Kata Kunci: ESP32, *load cell*, *monitoring* massa, pengeringan, pisang sale

DEVELOPMENT OF AN ESP32 MICROCONTROLLER-BASED MASS MONITORING SYSTEM FOR PISANG SALE DRYING

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ABSTRACT

The drying process of pisang sale requires periodic mass monitoring; however, manual weighing requires the product to be removed from the oven, which may disrupt the drying conditions and increase the risk of measurement errors. This study aimed to develop an ESP32-based mass monitoring system that monitors mass change as the primary parameter, with temperature and relative humidity (RH) as supporting parameters during the drying process of pisang sale. The system employed a *load cell* with an HX711 module for mass measurement, an SHT31 sensor for temperature and RH monitoring, and an ESP32 microcontroller for data processing and transmission to Google Sheets via an internet connection. System evaluation included sensor calibration and validation, data storage testing, and monitoring during drying under three temperature treatments. The *load cell* calibration results demonstrated an excellent linear relationship, with a coefficient of determination (R^2) of 0.99997. Validation results showed average measurement errors of 0.1% for mass, 3.29% for temperature, and 4.13% for RH. The system successfully monitored mass throughout the drying process, although data recording continuity was interrupted in several trials due to power outages and internet connection disruptions. Energy analysis indicated an estimated electrical energy consumption of 3.68–5.05 kWh, with drying efficiency ranging from 1.50% to 2.16%. The results demonstrate that the developed system is capable of monitoring mass during the drying process and providing mass change data as the primary parameter, while temperature and RH data serve as supporting information to describe the drying conditions.

Keywords: ESP32, *load cell*, mass monitoring, drying, Pisang Sale