

## EVALUASI PENGARUH POLA SUSUNAN KALENG RAPI DAN ACAK TERHADAP DISTRIBUSI PANAS PADA *RETORT* UAP JENUH VERTIKAL

### INTISARI

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Industri pengalengan pangan skala UMKM menghadapi tantangan dalam memastikan distribusi panas yang merata selama proses sterilisasi, karena ketidakseimbangan suhu dapat memengaruhi keamanan dan mutu produk. PT Hardjo Andrawina Nusantara (HAN), sebagai mitra UMKM, belum memiliki standar pola penyusunan kaleng dalam *retort* uap jenuh vertikal. Penelitian ini dilakukan untuk mengevaluasi pengaruh pola susunan kaleng rapi dan acak terhadap distribusi panas dalam *retort* tersebut. Metode penelitian menggunakan 215 kaleng *dummy* berisi air yang disusun dalam dua pola, dengan pemantauan suhu melalui 12 *thermocouple* tipe K di setiap tingkat susunan, dan data dianalisis menggunakan uji *Paired Sample t-Test* dan *Wilcoxon matched pairs test*.

Hasil penelitian menunjukkan bahwa pola susunan kaleng acak menghasilkan waktu *venting* lebih singkat ( $40,50 \pm 2,65$  menit) dibanding pola rapi ( $43,67 \pm 4,31$  menit) secara numerik, serta waktu *come-up time* (CUT) pada susunan acak lebih cepat ( $59,50 \pm 3,28$  menit) dibandingkan dengan susunan rapi ( $66,67 \pm 5,39$  menit). Stabilitas suhu *holding* pada susunan acak ( $122,9 \pm 0,33^\circ\text{C}$ ) lebih stabil dibandingkan pada susunan rapi ( $123,0 \pm 0,38^\circ\text{C}$ ). Proses *cooling* juga lebih efisien pada susunan acak ( $64,83 \pm 3,75$  menit) dibanding rapi ( $89,50 \pm 31,63$  menit). Sementara, titik terdingin (*cold spot*) terletak di bagian tengah pada tingkat kelima susunan kaleng di dalam *retort* untuk keduanya, namun variasi suhu lebih tinggi terjadi pada susunan rapi. Berdasarkan temuan ini, pola susunan acak direkomendasikan sebagai standar untuk meningkatkan efisiensi sterilisasi, menjamin keamanan produk, dan mengurangi potensi *overprocessing* pada pengalengan skala UMKM.

Kata kunci: *retort* uap jenuh vertikal, distribusi panas, susunan kaleng, sterilisasi.

**EVALUATION OF THE EFFECT OF REGULAR AND RANDOM CAN  
ARRANGEMENT ON TEMPERATURE DISTRIBUTION IN A VERTICAL  
SATURATED STEAM RETORT**

**ABSTRACT**

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The food canning industry at the MSME scale faces significant challenges in ensuring uniform heat distribution during sterilization processes, as temperature imbalances can critically affect product safety and quality. PT Hardjo Andrawina Nusantara (HAN), as an MSME partner, does not yet possess a standardized protocol for can arrangement within the vertical saturated steam retort. This study was conducted to evaluate the effect of regular and random can arrangement patterns on temperature distribution in a vertical saturated steam retort. The research employed 215 dummy cans filled with water, arranged in two different patterns, with temperature monitoring conducted through 12 type-K thermocouples positioned at various levels of the stack, and the data were analyzed using Paired Sample t-Test and Wilcoxon matched pairs test.

The results indicated that the random can arrangement produced a numerically shorter venting time ( $40.50 \pm 2.65$  minutes) compared to the regular arrangement ( $43.67 \pm 4.31$  minutes), and the come-up time (CUT) was also faster in the random arrangement ( $59.50 \pm 3.28$  minutes) than in the regular arrangement ( $66.67 \pm 5.39$  minutes). The cooling process was likewise more efficient in the random arrangement ( $64.83 \pm 3.75$  minutes) compared to the regular arrangement ( $89.50 \pm 31.63$  minutes). The holding temperature was also more stable in the random arrangement ( $122,9 \pm 0,33^{\circ}\text{C}$ ) than in regular arrangement ( $123,0 \pm 0,38^{\circ}\text{C}$ ). The cold spot was located centrally at the fifth level of the can stack in both cases, although greater temperature variation was observed in the regular arrangement. Based on these findings, the random can arrangement is recommended as the operational standard to enhance sterilization efficiency, ensure product safety, and minimize the risk of overprocessing in MSME-scale canning operations.

**Keywords:** vertical saturated steam retort, heat distribution, can arrangement, sterilization.