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Analysis of the Quality and Durability of SUS 304 Plates Used as Food Containers through Tensile and Deflection Tests

Intan Amita Waluya, Andril Arafat, Reza, Syahril, Mulianti
Universitas Negeri Padang, Indonesia
arafat@ft.unp.ac.id; intanamitawaluya2004@gmail.com

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Abstract

Stainless steel 304 (SUS 304) is widely used for food containers because of its corrosion resistance and suitability for food-contact applications. However, the occurrence of denting, wrinkling, and permanent deformation in some products suggests possible variations in material quality and mechanical performance. This study compared the chemical composition and mechanical properties of two types of SUS 304 food containers, designated Type 1 and Type 2. Chemical composition was determined using optical emission spectroscopy, while mechanical properties were evaluated through tensile testing in accordance with ASTM E8/E8M and deflection testing using the three-point bending method. The evaluated parameters comprised yield strength, ultimate tensile strength, elongation, maximum force, deflection modulus, and deflection strength. Chemical analysis confirmed that all specimens satisfied the compositional requirements for stainless steel 304 specified in ASTM A240. The mechanical test results showed that Type 1 specimens had greater tensile strength than Type 2 specimens. Type 1 also exhibited higher deflection modulus and deflection strength, although Type 2 recorded a slightly higher average maximum force. These findings indicate that Type 1 food containers possess greater stiffness and resistance to deformation and therefore demonstrate superior overall mechanical quality compared with Type 2 products. The study provides an evidence-based framework for evaluating material performance and strengthening quality-control procedures for SUS 304 food containers.

Keywords: SUS 304 Stainless Steel; Food Containers; Mechanical Properties; Tensile Testing; Three-Point Bending

INTRODUCTION

Eating utensils are an important component in the serving and storage of food because they directly affect the safety, hygiene, and quality of food consumed. Food containers must meet quality requirements in terms of both hygiene and mechanical properties to ensure that they can be used repeatedly without experiencing damage that may compromise their functionality or safety. Eating utensils that do not meet technical standards have the potential to undergo material degradation, become a source of contamination, and increase health risks for users in the long term (Wu et al., 2024).

Metal food containers are widely used in various sectors, including households, food service industries, educational institutions, hospitals, and large-scale food provision programs. One of the most widely used materials is *Stainless Steel 304* (SUS304) because of its good corrosion resistance, high-temperature resistance, hygienic properties, low reactivity with food, and relatively long service life compared with other materials (Rossi et al., 2024). SUS304 is an austenitic stainless steel that offers a good combination of strength, ductility, and corrosion resistance in accordance with ASTM A240, making it widely applied as a food-grade material.

Nevertheless, problems are still frequently encountered in the use of stainless steel food containers, such as denting, *wrinkling*, and permanent deformation after use (Miljojković et al., 2012). These conditions are suspected to be influenced by several factors, including excessively thin plate thickness, possible differences in material quality from the claimed specifications, and imperfections in manufacturing processes such as *deep drawing* and *stamping* (Liu et al., 2020). Mechanical loads during use, such as food weight, stacking, impacts, and repeated washing, may also contribute to the occurrence of deformation (Subasic et al., 2023).

Referring to the visual quality requirements specified in the Indonesian National Standard (SNI) 9369:2025, defects in the form of *wrinkling* have been identified in food container products, raising concerns that these products may not comply with the established quality requirements. Therefore, mechanical property testing through tensile and deflection tests is necessary. Tensile testing is conducted to determine the material's ability to withstand tensile loads based on the values of *Yield Strength, Ultimate Tensile Strength* (UTS), and *Elongation*. Deflection testing is conducted to evaluate the material's ability to withstand bending loads through the parameters of *Deflection Modulus, Deflection Strength*, and *Maximum Force*, thereby providing an indication of the material's behavior under actual service conditions (Bai et al., 2018). This study aims to analyze and compare the mechanical properties of food containers made of *Stainless Steel 304* (SUS304) classified as TYPE 1 and TYPE 2 through tensile and deflection testing.

METHODS

This study employed a quantitative method to analyze the mechanical properties and physical conditions of food containers made of *Stainless Steel 304* (SUS304), including TYPE 1 and TYPE 2. Samples were collected from three sections of the food containers, namely the side, lid, and bottom sections, representing areas with different levels of deformation resulting from the *deep drawing* process.

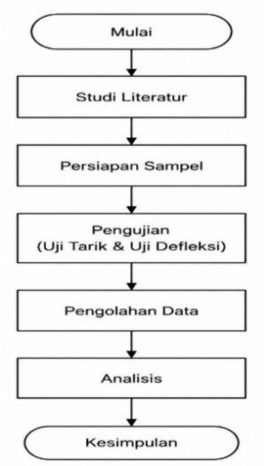

Figure 1. Research Flowchart

1. Sample Preparation

This study employed a descriptive quantitative method to compare the mechanical properties of SUS 304 food containers classified as TYPE 1 and TYPE 2. Samples were collected from three sections of the food containers, namely the side, lid, and bottom sections, representing different levels of deformation resulting from the *deep drawing* process.

Figure 2. Food Container Sample Sections

a. Chemical Composition Test

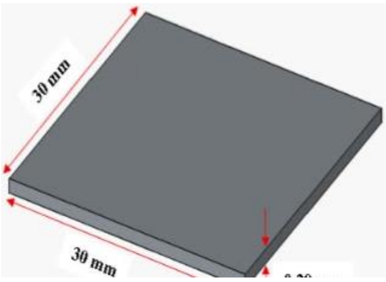

Figure 3. Chemical Composition Test Sample

Chemical composition testing was conducted using *Optical Emission Spectroscopy* (OES) at the Center for Material Processing and Failure Analysis (CMPFA) Laboratory, Faculty of Engineering, Universitas Indonesia, in accordance with ASTM E1086. The specimens, measuring 30 mm × 30 mm, were tested at three different points, and the results were averaged to obtain representative data. The obtained results were then compared with the requirements specified in ASTM A240 to determine the conformity of the material *grade*.

b. Tensile Test

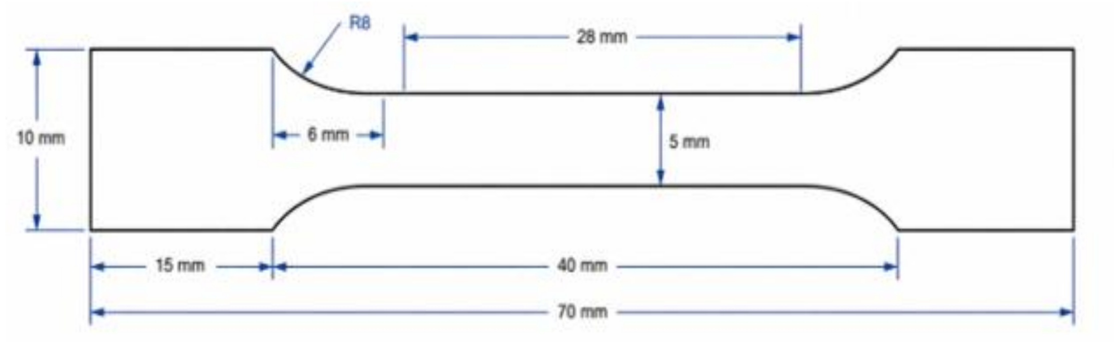

Figure 4. Tensile Test Sample

The tensile test was conducted using a *Universal Testing Machine* (UTM) in accordance with ASTM E8/E8M. The specimens were prepared in a *dumbbell* (dog-bone) shape with a thickness of 0.3 mm, a parallel length of 28 mm, a wider width of 10 mm, and a narrower width of 5 mm. The specimens were taken from the flat area of the food containers to ensure uniform stress distribution and minimize the influence of geometric deformation resulting from the *deep drawing* process (Li, Y., Xu & Luan, 2025). The analyzed parameters included *Yield Strength, Ultimate Tensile Strength* (UTS), and *Elongation*, which were subsequently compared with the minimum requirements specified in JIS G4305.

c. Deflection Test

Figure 5. Deflection Test Sample

The deflection test was conducted using the Deflection method in accordance with ASTM E290 using a *Universal Testing Machine* (UTM) equipped with a three-point support fixture (Seemuang et al., 2017). The specimens, measuring 80 mm in length, 15 mm in width, and 0.3 mm in thickness, were placed on two supports with a span distance of 50 mm. A load was then applied at the center of the span through a *loading nose* with a diameter of 3–5 mm. The analyzed parameters included *Maximum Force, Deflection Modulus*, and *Deflection Strength.*

Both tests were performed on each specimen section (side, lid, and bottom) for TYPE 1 and TYPE 2 products, resulting in six data groups for the tensile test and six data groups for the deflection test. The results from both tests were subsequently compared to evaluate the mechanical quality of TYPE 1 food containers relative to TYPE 2.

2. Experimental Design

In this study, chemical composition testing, tensile testing, and Deflection testing were conducted on TYPE 1 and TYPE 2 food containers made of SUS 304 *stainless steel.* Chemical composition testing was performed to identify the constituent elements of the material, while tensile testing was conducted to obtain the values of *Yield Strength, Ultimate*

Tensile Strength (UTS), and *Elongation*. Deflection testing was performed to obtain the values of *Maximum Force, Deflection Modulus*, and *Deflection Strength*. All test results were subsequently analyzed comparatively with reference to the JIS G4305 standard to evaluate the effect of the manufacturing process on the mechanical properties of the material.

Table 1. Experimental Design

No.	Food Container Type	Specimen Section
1	TYPE 1	Side
2	TYPE 1	Lid
3	TYPE 1	Bottom
4	TYPE 2	Side
5	TYPE 2	Lid
6	TYPE 2	Bottom

RESULTS

1. Chemical Composition Test Results

The results of the chemical composition analysis using OES showed that the contents of the main elements, particularly chromium (Cr) and nickel (Ni), in all specimens (TYPE 1 lid, TYPE 2 lid, TYPE 1 container, and TYPE 2 container) were within the ranges specified by ASTM A240 for *Stainless Steel* 304, as presented in Table 2.

Table 2. Chemical Composition Test Results

Element	TYPE 2 Lid (%)	TYPE 1 Lid (%)	TYPE 2 Container (%)	TYPE 1 Container (%)	ASTM A240
Carbon	0.042	0.042	0.037	0.044	0.07
Silicon	0.233	0.407	0.328	0.357	0.75
Phosphorus	0.017	0.019	0.013	0.016	0.045
Sulfur	0.014	0.023	0.014	0.015	0.030
Chromium	19.07	18.28	18.92	19.33	17.5–19.5
Manganese	0.869	1.266	0.888	1.111	2.00
Iron	71.21	71.22	71.02	70.42	Balance
Nickel	8.049	8.227	8.268	8.166	8.0–10.5

2. Tensile Test Results

The tensile test results for the six specimens were compared with the minimum requirements specified in JIS G4305 (*Yield Strength* ≥205 MPa, UTS ≥520 MPa, and *Elongation* ≥40%), as presented in Table 3.

Table 3. Tensile Test Results

Specimen	Yield Strength (MPa)	UTS (MPa)	Elongation (%)
JIS G4305	≥205	≥520	≥40
TYPE 1 Side	654.01	836.84	29
TYPE 1 Lid	404.34	691.63	44
TYPE 1 Bottom	459.88	729.17	43
TYPE 2 Lid	457.58	615.10	12
TYPE 2 Side	321.89	496.41	37
TYPE 2 Bottom	470.60	667.11	32
Average TYPE 1	506.08	752.55	38.67
Average TYPE 2	416.69	592.87	27.00

3. Deflection Test Results

The deflection test results showed that the TYPE 1 specimens exhibited better bending properties than the TYPE 2 specimens.

Table 4. Deflection Test Results

Specimen	Maximum Force (N)	Modulus Bending (N/mm^2)	Bending Strength (N/mm^2)
TYPE 1 Side	98.364	102,850.874	1,221.052
TYPE 1 Bottom	62.785	105,594.378	5,014.108
TYPE 1 Lid	95.224	69,893.660	4,425.164
TYPE 2 Lid	73.459	19,785.632	1,722.441
TYPE 2 Side	103.596	13,994.848	1,550.593
TYPE 2 Bottom	81.621	8,940.417	1,061.331
Average TYPE 1	85.458	61,924.637	3,553.441
Average TYPE 2	86.225	14,240.299	1,444.788

4. Effect of Chemical Composition on Mechanical Properties

The chemical composition test results showed that the contents of the main elements, particularly chromium (Cr) and nickel (Ni), in all TYPE 1 and TYPE 2 specimens remained within the ranges specified by ASTM A240 for SUS 304. This conformity indicates that the differences in mechanical properties observed among the specimens were not caused by differences in material *grade* or deviations in chemical composition.. Mechanical properties are also influenced by other factors, such as microstructure, manufacturing processes, and the deformation history experienced by the material. Therefore, although the chemical composition test results in this study indicate that all specimens meet the specifications for SUS 304 *stainless steel*, the differences in mechanical properties are suspected to be more strongly influenced by the forming processes during manufacturing.

Rather, these differences are more strongly influenced by the history of manufacturing processes, such as *deep drawing, cold working,* and *stamping*, experienced by the material during the forming process . Material *grade* determination was based on the average values obtained from chemical composition testing conducted by a laboratory accredited by the Komite Akreditasi Nasional (KAN). Therefore, the test results have an adequate level of reliability to serve as a basis for material *grade* identification. Accordingly, all differences in mechanical properties discussed in the following sections are interpreted within the framework that the base material remains SUS 304.

5. Tensile Test Results

a. Discussion of TYPE 1

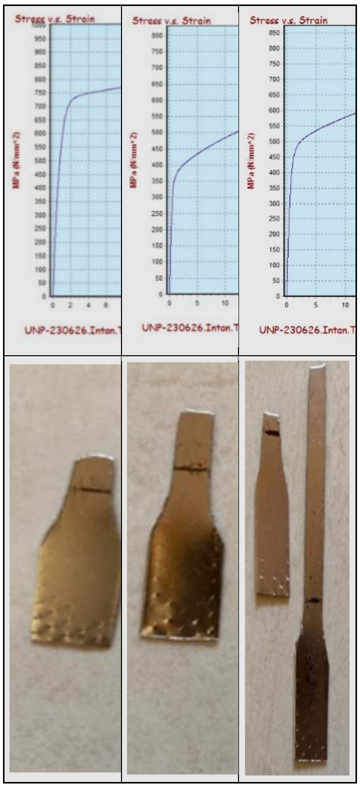

Figure 6. Tensile Test Results for TYPE 1 Side, Bottom, and Lid Sections.

The test results showed that all TYPE 1 specimens met the requirements for *Yield Strength* and *Ultimate Tensile Strength* (UTS) according to JIS G4305, namely ≥205 N/mm² and ≥520 N/mm², respectively. However, the TYPE 1 Side specimen exhibited an *Elongation* of 29%, which did not meet the minimum requirement of 40%. Meanwhile, the TYPE 1 Lid and TYPE 1 Bottom specimens exhibited *Elongation* values of 44% and 43%, respectively, and therefore met the standard.

The differences in *Elongation* cannot be explained solely by thickness. The TYPE 1 Side specimen had a thickness of 0.33 mm and an *Elongation* of 29%, whereas the thinner TYPE 1 Bottom specimen, with a thickness of 0.31 mm, exhibited an *Elongation* of 43%. This indicates that thickness is not the only factor affecting material ductility.

Previous studies have shown that SUS 304 with a thickness of approximately 0.30 mm can exhibit varying mechanical properties. reported a *Yield Strength* of 786 N/mm², UTS of 1160 N/mm², and *Elongation* of 26.4%, whereas Huang & Lu (2022) obtained a *Yield Strength* of 326 N/mm², UTS of 780 N/mm², and *Elongation* of 35%. The *Elongation* value of 29% obtained for the TYPE 1 Side specimen remains within the range reported in these studies. The relatively high *Yield Strength* and UTS accompanied by lower *Elongation* in the TYPE 1 Side specimen are suspected to be associated with strain hardening caused by deformation during the forming process.

b. TYPE 2

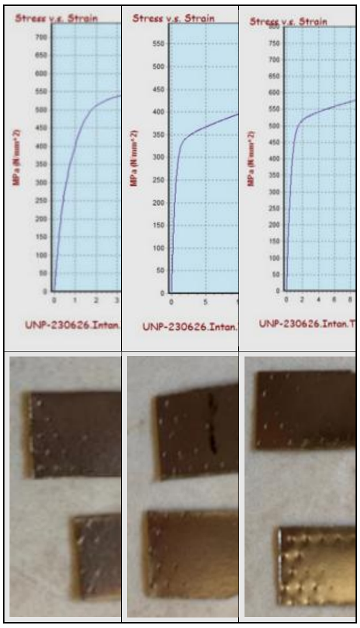

Figure 7. Tensile Test Results for TYPE 2 Side, Bottom, and Lid Sections.

Based on the tensile test results, the main problems identified in TYPE 2 were related to *Ultimate Tensile Strength* (UTS) and *Elongation*. According to JIS G4305, the minimum UTS and *Elongation* values for SUS 304 are 520 N/mm² and 40%, respectively. The TYPE 2 Side specimen had a UTS of 496.41 N/mm², which was 4.54% below the standard, while all TYPE 2 specimens exhibited *Elongation* values below the standard, namely 12% for TYPE 2 Lid, 37% for TYPE 2 Side, and 32% for TYPE 2 Bottom. Thus, non-conformity in UTS was found only in the TYPE 2 Side specimen, whereas low *Elongation* occurred in all sections.

The TYPE 2 Lid specimen exhibited the lowest *Elongation*, at 12%. This value indicates a low capacity for plastic deformation. This condition is suspected to be associated with deformation and strain hardening during the forming process. Therefore, the low *Elongation* of the TYPE 2 Lid specimen is suspected to be related to the material's deformation history during manufacturing.

The differences in *Elongation* among the sections are not determined solely by thickness. The TYPE 2 Side specimen, with a thickness of 0.31 mm, exhibited an *Elongation* of 37%, whereas the thinner TYPE 2 Bottom specimen, with a thickness of 0.26 mm, exhibited an *Elongation* of 32%. Therefore, the differences in *Elongation* among TYPE 2 sections are suspected to be associated with differences in the degree and direction of deformation experienced during the forming process.

The TYPE 2 Side specimen also exhibited the lowest UTS, at 496.41 N/mm², despite having the highest *Elongation* of 37%. This condition cannot be explained solely by thickness because the thinner TYPE 2 Bottom specimen exhibited a UTS of 667.11 N/mm². Therefore, the low UTS of the TYPE 2 Side specimen is suspected to be associated with the deformation conditions and deformation history experienced by that section during the forming process.

6. Deflection Test Results

a. Deflection Test Results of TYPE 1

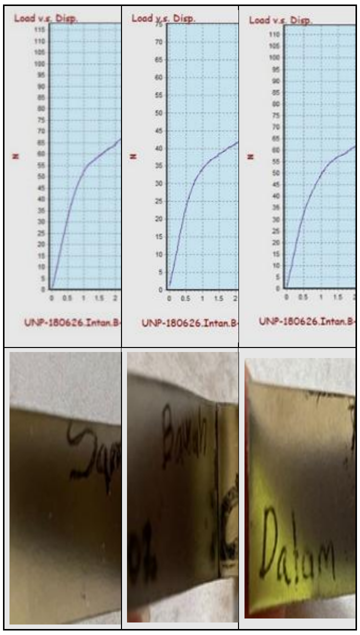

Figure 8. Deflection Test Results for TYPE 1 Side, Bottom, and Lid Sections.

Based on Figure 8, the Deflection test results showed that the TYPE 1 specimens exhibited different bending characteristics across the sections of the food container. The highest *Maximum Force* was obtained by the TYPE 1 Side specimen, at 98.364 N, followed by the TYPE 1 Lid specimen at 95.224 N, while the TYPE 1 Bottom specimen exhibited the lowest value, at 62.785 N. This indicates that the side section was capable of withstanding a greater bending load before experiencing permanent deformation.

In contrast, the TYPE 1 Bottom specimen exhibited the highest *Modulus Defleksi* and *Defleksi Strength*, with values of 105,594.378 N/mm² and 5,014.108 N/mm², respectively. These were followed by the TYPE 1 Lid specimen, with values of 69,893.660 N/mm² and 4,425.164 N/mm², respectively, while the TYPE 1 Side specimen exhibited the lowest values, namely 10,285.874 N/mm² and 1,221.052 N/mm². A high *Modulus Defleksi* indicates that the material has better stiffness under bending loads. Meanwhile, a high *Defleksi Strength* indicates a greater ability of the material to withstand bending stress before failure. These differences indicate that *Maximum Force* is not always accompanied by a high *Modulus Defleksi* and *Defleksi Strength*.

The chemical composition test results showed that the Cr and Ni contents of all specimens remained within the requirements for SUS 304 *stainless steel*. Therefore, the differences in bending properties observed in this study were more strongly influenced by manufacturing processes, such as *rolling, cold working,* and *deep drawing*, rather than differences in the chemical composition of the material.

b. Deflection Test Results of TYPE 2

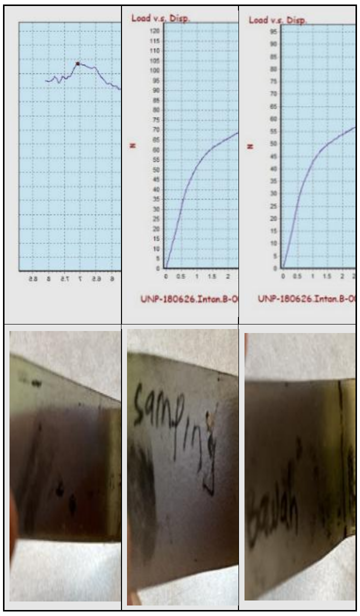

Figure 9. Deflection Test Results for TYPE 2 Side, Bottom, and Lid Sections.

Based on Figure 9, the Deflection test results showed that the TYPE 2 specimens exhibited different bending characteristics across the sections of the food container. The highest *Maximum Force* was obtained by the TYPE 2 Side specimen, at 103.596 N, followed by the TYPE 2 Bottom specimen at 81.621 N, while the TYPE 2 Lid specimen exhibited the lowest value, at 73.459 N. The *Maximum Force* value indicates the ability of the material to withstand the maximum bending load before experiencing permanent deformation or failure.

However, a different trend was observed for *Modulus Defleksi* and *Defleksi Strength*. The TYPE 2 Lid specimen exhibited the highest *Modulus Defleksi*, at 19,785.632 MPa, and *Defleksi Strength*, at 1,722.441 MPa, followed by the TYPE 2 Side specimen, with values of 13,994.848 MPa and 1,550.593 MPa, respectively. Meanwhile, the TYPE 2 Bottom specimen exhibited the lowest values, namely 8,940.417 MPa and 1,061.331 MPa.

These results demonstrate that *Maximum Force* is not necessarily proportional to *Modulus Defleksi* or *Defleksi Strength*. Although the TYPE 2 Side specimen was capable of withstanding the highest maximum load, it exhibited lower stiffness and bending resistance than the TYPE 2 Lid specimen. Conversely, the TYPE 2 Lid specimen demonstrated a better ability to maintain stiffness and withstand bending stress despite being subjected to a lower maximum load.

Based on the Deflection test results, the TYPE 2 specimens exhibited variations in *Maximum Force, Modulus Defleksi,* and *Defleksi Strength* across the different sections of the food container. These variations indicate that the material's ability to withstand bending loads, stiffness, and resistance to deformation were not uniform. This condition causes some sections of the food container to be more susceptible to permanent deformation, such as denting and *wrinkling*, which is consistent with field observations. The chemical composition test results showed that all specimens still met the requirements for SUS 304 *stainless steel*. Therefore, the differences in bending properties are suspected to be more strongly influenced by manufacturing processes, such as *rolling, cold working,* and *deep drawing*, rather than differences in the chemical composition of the material.

7. Comparison of the Mechanical Properties of TYPE 1 and TYPE 2 Based on Tensile and Deflection Tests

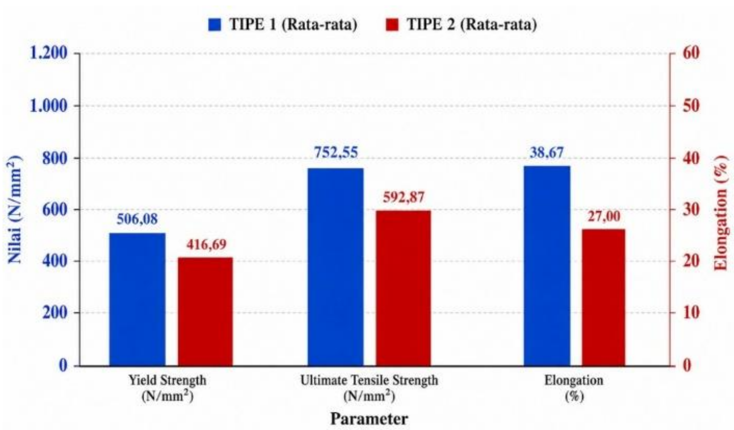

Figure 10. Comparison of Mechanical Properties Based on Tensile Testing.

The results showed that TYPE 1 specimens exhibited better mechanical properties than TYPE 2 specimens in both the tensile and Deflection tests. In the tensile test, the average *Yield Strength, Ultimate Tensile Strength* (UTS), and *Elongation* of TYPE 1 were 506.08 MPa, 752.55 MPa, and 38.67%, respectively, which were higher than those of TYPE 2, at 416.69 MPa, 592.87 MPa, and 27.00%, respectively. These results indicate that TYPE 1 exhibited higher strength and ductility. According to, an increase in material strength can be influenced by the *strain hardening* mechanism, while explained that plastic deformation during the forming process can increase dislocation density, thereby affecting the mechanical properties of the material.

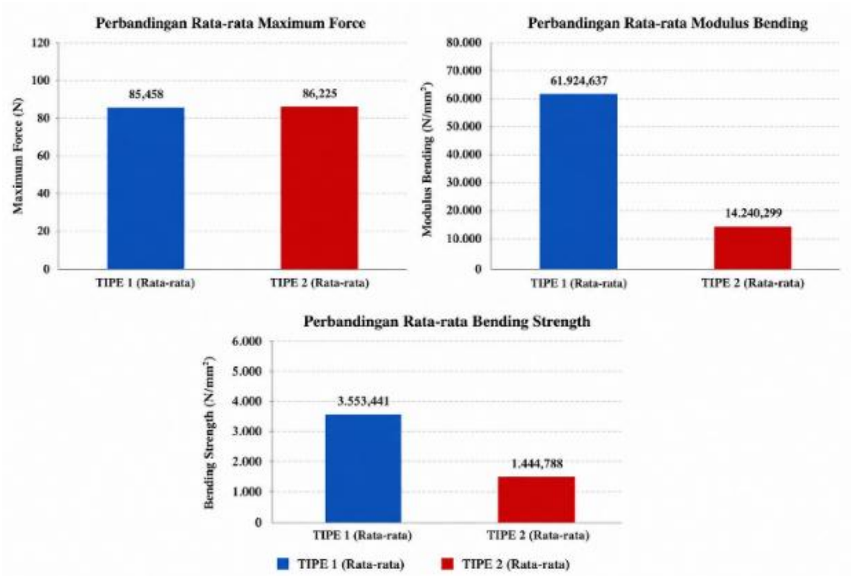

Figure 11. Comparison of Mechanical Properties Based on Deflection Testing.

In the Deflection test, the average *Modulus Defleksi* and *Defleksi Strength* of TYPE 1 were 61,924.637 N/mm² and 3,553.441 N/mm², respectively, which were higher than those of TYPE 2, at 14,240.299 N/mm² and 1,444.788 N/mm², respectively. These conditions indicate that TYPE 1 exhibited higher stiffness and a greater ability to withstand bending stress. Meanwhile, the average *Maximum Force* values of TYPE 1 and TYPE 2 were 85.458 N and 86.225 N, respectively, indicating relatively similar values. This finding indicates that *Maximum Force* is influenced not only by material properties but also by specimen geometry and testing conditions.

DISCUSSION

The results of this study indicate that the quality and mechanical durability of SUS 304 plates used as food containers are determined not only by their chemical composition compliance but also by the mechanical condition of the material after undergoing manufacturing processes. The chemical composition test results showed that all TIPE 1 and TIPE 2 specimens remained within the composition range required for SUS 304 stainless steel. This condition indicates that both types of containers have relatively similar base materials in terms of grade; therefore, the differences in mechanical properties identified through tensile and deflection tests are more appropriately attributed to the material condition after the forming process. This finding is consistent with (Cui et al., 2017), who explained that the relationship between composition, microstructure, and material properties is not straightforward, as mechanical characteristics are also influenced by microstructure and material processing conditions. Therefore, compliance with the chemical composition requirements cannot be used as the sole indicator for determining the mechanical quality of SUS 304 plates (Subasic et al., 2023).

The differences in mechanical properties between TIPE 1 and TIPE 2 are strongly presumed to be associated with the deformation history during manufacturing processes, particularly rolling, cold working, stamping, and deep drawing. These processes can induce changes in the material structure and stress distribution, resulting in different mechanical responses in the side, bottom, and lid sections of the containers. By (Vrh et al., 2011) explained that cold forming of stainless steel sheets can alter the effective elastic properties of the material as a consequence of deformation during forming. A similar finding was reported by (Odnobokova et al., 2015), who demonstrated that cold working of stainless steel can increase material strength through the strain hardening mechanism while simultaneously reducing its ability to undergo plastic deformation. These findings may explain the results obtained in the present study, particularly the condition in which specimens with relatively high strength exhibited lower elongation values.

In the tensile test, TIPE 1 generally demonstrated better performance than TIPE 2. The average Yield Strength, UTS, and Elongation values of TIPE 1 were 506.08 MPa, 752.55 MPa, and 38.67%, respectively, whereas TIPE 2 achieved only 416.69 MPa, 592.87 MPa, and 27.00%, respectively. These results indicate that TIPE 1 exhibited a better combination of strength and ductility. Nevertheless, considerable variation was observed among the different sections within each container type. In TIPE 1, the side section exhibited an Elongation of 29%, which did not meet the minimum requirement of 40% specified by JIS G4305, whereas the lid and bottom sections achieved Elongation values of 44% and 43%, respectively. This condition indicates that thickness is not the only factor determining material ductility, as the thinner TIPE 1 Bottom specimen, with a thickness of 0.31 mm, exhibited higher Elongation than the TIPE 1 Side specimen, which had a thickness of 0.33 mm. Research (Coello et al., 2010) demonstrated that the deformability of AISI 304 can be influenced by the initial hardening condition and loading conditions during the forming process. Li et al. (2025) also reported that deformation characteristics and forming limits in thin SUS 304 sheets are strongly associated with deep-drawing process conditions.

In TIPE 2, the mechanical limitations were more pronounced, particularly in terms of UTS and Elongation. The TIPE 2 Side specimen exhibited a UTS of 496.41 MPa, approximately 4.54% below the minimum requirement of 520 MPa, while all TIPE 2 sections exhibited Elongation values below the required 40%. The lowest Elongation was observed in the TIPE 2 Lid specimen, at only 12%, followed by the TIPE 2 Bottom and TIPE 2 Side specimens, with values of 32% and 37%, respectively. The low Elongation values indicate a reduction in the material's ability to undergo plastic deformation. This condition can be associated with strain hardening resulting from the forming process. Research (Mukhopadhyay et al., 1993) demonstrated that the cold-worked condition of AISI 304 is associated with changes in the material response during tensile deformation. Furthermore, (Cios et al., 2017) explained that deformation in AISI 304 can induce the formation of strain-induced martensite, which contributes to changes in the mechanical behavior of the material. Therefore, the low Elongation observed in TIPE 2 does not necessarily indicate a difference in material grade but rather suggests differences in the deformation conditions and hardening experienced by the material during manufacturing.

The deflection test results also revealed substantial differences in the mechanical responses between TIPE 1 and TIPE 2. For TIPE 1, the average Modulus Defleksi reached 61,924.637 N/mm², while the Defleksi Strength was 3,553.441 N/mm². In contrast, TIPE 2 exhibited values of only 14,240.299 N/mm² and 1,444.788 N/mm², respectively. These results indicate that TIPE 1 possessed greater stiffness and a higher ability to withstand bending stress. However, the Maximum Force values of the two types were relatively similar, at 85.458 N for TIPE 1 and 86.225 N for TIPE 2. This finding indicates that the maximum load-bearing capacity is not necessarily proportional to material stiffness. Research (Jindra et al., 2021) demonstrated that the results of three-point bending tests are influenced not only by material characteristics but also by specimen configuration, geometry, and loading conditions. Research (Maleki et al., 2024) also demonstrated that bending tests can be used to evaluate the response of materials to bending loads and to identify their stiffness and deformation characteristics.

The differences in deflection responses among the various sections of the containers demonstrate that geometry and forming history play important roles in mechanical durability. In TIPE 1, the highest Maximum Force was observed in the side section, at 98.364 N; however, the Modulus Defleksi and Defleksi Strength were the lowest, at 10,285.874 N/mm² and 1,221.052 N/mm², respectively. Conversely, the bottom section exhibited the lowest

Maximum Force, at 62.785 N, but had the highest Modulus Defleksi and Defleksi Strength, reaching 105,594.378 N/mm² and 5,014.108 N/mm², respectively. A similar pattern was observed in TIPE 2, in which the side section exhibited the highest Maximum Force, at 103.596 N, whereas the lid section exhibited the highest Modulus Defleksi and Defleksi Strength. These findings demonstrate that Maximum Force, stiffness, and resistance to bending stress represent different mechanical parameters and therefore do not necessarily produce the same performance ranking. Research (Yan et al., 2023) explained that deformation distribution during three-point bending tests of 304 stainless steel can produce different mechanical responses depending on loading conditions and material characteristics. Meanwhile, (Vrh et al., 2011) demonstrated that cold-forming processes can affect the elastic properties and mechanical response of stainless steel sheets.

Overall, the results demonstrate that TIPE 1 has better mechanical quality and durability than TIPE 2 based on the combined results of the tensile and deflection tests. The superiority of TIPE 1 is reflected in its higher average Yield Strength, UTS, and Elongation, as well as its substantially higher Modulus Defleksi and Defleksi Strength values. In contrast, TIPE 2 exhibited a greater tendency toward permanent deformation, particularly due to its lower Elongation and bending stiffness in several sections. This condition may increase the potential for mechanical defects such as denting and wrinkling when the containers are subjected to loads during distribution and use. These findings reinforce the results of (Chang & Chou, 1996), who demonstrated that deep drawing of 304 stainless steel produces different deformation conditions in different sections of the material. Therefore, the quality of food containers made from SUS 304 should be evaluated not only based on chemical composition compliance but also based on mechanical properties and the consistency of the forming process.

Accordingly, the analysis of the quality and durability of SUS 304 plates in this study demonstrates that material compliance with the applicable standard does not automatically guarantee uniform mechanical performance in the final product. Although all specimens were derived from material whose chemical composition met the characteristics of SUS 304, differences in manufacturing processes and deformation history can produce variations in strength, ductility, stiffness, and resistance to bending loads. These findings are consistent with (Coello et al., 2010; Al-Bakri et al., 2017; Huang & Lu, 2022; Vrh et al., 2011; Maleki et al., 2024), who emphasized the importance of deformation conditions and forming processes in determining the mechanical behavior of 304 stainless steel. Therefore, quality control in the production of food containers should include control of plate thickness, deep-drawing and stamping parameters, and the degree of deformation to achieve more consistent strength, ductility, and stiffness. Through such control, the use of SUS 304 as a material for food containers can provide improved mechanical durability while reducing the risk of permanent deformation during use.

CONCLUSION

Based on the results of the chemical composition, tensile, and *three-point bending* tests, it can be concluded that both TYPE 1 and TYPE 2 specimens met the chemical composition requirements for SUS 304 *stainless steel*. However, TYPE 1 specimens exhibited better mechanical properties than TYPE 2 specimens. In the tensile test, all specimens met the *Yield Strength* requirement, but several TYPE 2 specimens did not meet the requirements for *Ultimate Tensile Strength* (UTS) and *Elongation*. In the *three-point bending* test, TYPE 1 specimens also demonstrated better stiffness and bending resistance than TYPE 2 specimens. These differences in mechanical properties are suspected to be more strongly influenced by manufacturing processes, such as *rolling, cold working,* and *deep drawing*, rather than differences in the chemical composition of the material. This condition causes several TYPE 2 specimens to have a lower capacity to withstand tensile and bending loads, making them more susceptible to permanent deformation, such as denting and *wrinkling*, during the distribution and use of the food containers. These findings emphasize the importance of quality control in the *deep drawing* and *stamping* processes, as well as consistency in plate thickness, to reduce defects such as denting and *wrinkling*. They also support the use of food containers meeting SNI standards as a more reliable option in terms of strength, stiffness, and resistance to deformation.

This study contributes to providing empirical evidence regarding the mechanical quality and durability of SUS 304 plates used in food containers through a combination of tensile and deflection tests. The main contribution of this study lies in identifying differences in mechanical performance between TIPE 1 and TIPE 2, as well as differences in mechanical responses among the side, bottom, and lid sections of the containers, thereby identifying the material sections that are relatively more susceptible to deformation. The results also demonstrate that compliance with the chemical composition requirements for SUS 304 does not directly guarantee uniform mechanical properties in the final product. These findings can serve as a basis for manufacturers in evaluating material quality and controlling manufacturing processes, particularly the forming processes used in food container production, to produce products with more consistent strength, ductility, stiffness, and resistance to deformation.

Future research is recommended to conduct more comprehensive material characterization by incorporating microstructural analysis, hardness testing, residual stress measurement, and determination of the strain-induced martensite fraction to provide a deeper understanding of the factors responsible for the differences in mechanical properties between TIPE 1 and TIPE 2. In addition, future studies could expand the number of samples by including products from different manufacturers and variations in plate thickness, while controlling the specimen sampling direction relative to the rolling direction to investigate the effect of material anisotropy. Three-point bending tests could also be combined with Finite Element Method (FEM) simulations to analyze the distribution of stress and deformation in the side, bottom, and lid sections of the food containers. Further studies are also recommended to evaluate resistance to cyclic loading, fatigue, and corrosion under conditions that simulate actual food-contact environments, thereby providing a more comprehensive assessment of the safety, service life, and reliability of SUS 304 food containers.

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