Journal of Scientific and Human Dimensions
مجلة الأبعاد العلمية والإنسانية
ISSN: 3106-1702
Volume 2, Issue 3, 2026 Pages: 345-350
Journal homepage: https://jshd.com.ly/index.php/jshd/en

Effect of Salt Stress on Germination Characteristics and Osmolyte Accwnulation of Four Wheat Cultivars

Abdulbasit Altayib Alashemi Al-dueaki [1 *], Wijdan Basher Alearbi [2], Reham Saleh Abroud [3], Rehan Mustafa Ghoneim[4], Maryam Mohammed Baraka[5]

[1,3,4,5] Department of Biology, Faculty of science, University of Gharyan City, State, Libya
[2] Department of Biology, Faculty of Science University of Zawia, Zawia, Libya

تأثير الإجهاد الملحي على خصائص الإنبات وتراكم المواد المذابة في أربعة أصناف من القمح

عبدالباسط الطيب الهاشمي الدعيكي [1*]، وجدان بشير العربي [2*]، رهام صالح العبرود [3]، ريحان مصطفى غنيه [4] ، مريم محمد بركه [5]
[1،3،4،5] قسم النبات، كلية العلوم، جامعة غريان، مدينة غريان، دولة ليبيا
[2] قسم النبات، كلية العلوم، جامعة الزاوية، مدينة الزاوية، دولة ليبيا

[*]Corresponding author: 55ashram65@gmail.com

Received: June16, 2026	Accepted: July 25, 2026	Published: August 04, 2026

Abstract:
This study was conducted in the laboratory of the Botany Department, Faculty of Science, Gharyan University, during the 2024/2025 growing season to determine the effect of different salinity levels on the germination rate (%) and germination strength index, as well as the proline and sugar content in the leaves of some wheat varieties. A range of sodium chloride concentrations (0, 100, and 200 mmol) were used. Seeds of soft wheat varieties (Sidi El Masri and Marshoush) and durum wheat varieties (Erazol and Abu El Shouk). A completely randomized design (CRD) with three treatments and five replicates for each variety was employed.
The results showed significant differences in the percentage of germination and germination strength index for all concentrations used and for all varieties. Significant differences were also observed in the leaf proline and sugar content for all varieties.

Keywords: Salinity, Germination, Varieties of wheat

الملخص
أجريت هذه الدراسة في مختبر قسم علم النبات، كلية العلوم، جامعة غريان، خلال موسم النمو 2025/2024، لتحديد تأثير مستويات مختلفة من الملوحة على معدل الإنبات (%) ومؤشر قوة الإنبات، بالإضافة إلى محتوى البرولين والسكريات في أوراق بعض أصناف القمح. استُخدمت مجموعة من تراكيز كلوريد الصوديوم (0، 100، و200 ملي مول). وشملت الدراسة بذور أصناف القمح الطري (سيدي المصري ومرشوش) وأصناف القمح القاسي (إرازول وأبو الشوك). وتم تطبيق تصميم عشوائي كامل بثلاث معاملات وخمسة مكررات لكل صنف.
أظهرت النتائج فروقًا معنوية في نسبة الإنبات ومؤشر قوة الإنبات لجميع التراكيز المستخدمة ولجميع الأصناف. كما لوحظت فروق معنوية في محتوى البرولين والسكريات في الأوراق لجميع الأصناف

الكلمات المفتاحية: الملوحة، الإنبات، أصناف القمح.

Introduction

Wheat is considered one of the most important agricultural crops that humans have cultivated and improved for thousands of years. It ranks second in global grain production after maize. The harvested area worldwide in 2018 reached approximately 215.33 million hectares, with production around 730.55 million tons (USDA, 2019). The European Union, China, India, Russia, the United States, Canada, and Australia are among the largest wheat-producing countries (USDA, 2019).

As a staple crop worldwide, wheat has prompted researchers to study it from morphological and physiological perspectives to increase its productivity, improve its quality, and identify suitable and unsuitable growing conditions. Among the environmental factors affecting production and yield is salinity. Salinity is considered one of the most prominent abiotic stressors that hinders achieving these goals. It threatens plant resources, reduces production efficiency, and leads to morphological disturbances at various stages of growth.

Salinity negatively affects all germination and growth characteristics (Fercha and Gherroucha, 2014). It can affect seed germination either by imposing external osmotic pressure, preventing seeds from absorbing water, or through ion toxicity, which hinders the mobilization and assimilation of food reserves by cells, thus preventing cell division and delaying germination, potentially leading to seed death (Zhang et al., 2010) .

Therefore, this study aimed to investigate the response mechanisms of wheat varieties to salt stress and its impact on growth and development. The goal was to identify differences in the response of each studied variety to salt stress by addressing the following research question: To what extent does salt stress affect the germination and growth of wheat varieties (Triticum sp.).

Study Objective:

This study aims to determine the effect of irrigation water salinity at concentrations of (0, 100, and 200 m/mol) of sodium chloride salts on some physiological and biochemical characteristics of four wheat varieties cultivated in Libya: Sidi El Masri, Marshoush, Erazol, and Abu El Shouk. It also aims to compare the response of these varieties to salinity concentrations during the germination and growth stages to identify salt-resistant and salt-sensitive varieties.

Practical Part:

A laboratory experiment was conducted as the first stage of the study in the laboratory of the Botany Department at the Faculty of Science, Gharyan University during the 2024/2025 agricultural season to study the effect of irrigation water salinity on the germination rate and average germination time of four wheat varieties. In this study, a range of sodium chloride concentrations (0, 100, and 200 mM) were used. Seeds of soft wheat varieties (Sidi El Masri and Marshoush) and durum wheat varieties (Erazol and Abu Shouk) were used. Wheat seeds of all varieties were sown in Petri dishes on germination paper using sterile forceps after the glassware containing the Petri dishes and germination paper had been sterilized. Water was added according to the required concentration for each treatment and for each replicate. A completely randomized design (CRD) was used with three treatments and five replicates for each variety. The germination rate was recorded during the experimental period, which ranged from 3 to 8 days, and the average germination time was calculated. In the second phase of the study, the seeds were sown in plastic pots containing potting soil collected from a farm in Gharyan during the 2024/2025 growing season, according to the laboratory design. The seeds were irrigated with water without treatment for approximately 15 days. After germination, the plants were irrigated with the treatment water according to the concentrations used in the In a laboratory experiment conducted over a 21-day period, adjusting humidity levels accordingly, leaf samples were collected from all replicates and treatments to estimate leaf proline content (as described by Troll and Lindsey, 1956) and sugar content (as described by Dubois et al., 1956).

Data analysis was performed using SPSS software, employing measures of central tendency and one-way and two-way ANOVA. Differences between means were tested using the Least Significant Difference (LSD) test at a significance level of 0.05%.

Results and Discussion:

Effect of Salinity on Germination Rate:

The results obtained and shown in Figure (1) clearly demonstrate the effect of salinity on the germination rate of the studied varieties. The highest germination rate was observed in the control treatment, reaching 100% for both the Sidi El Masry and Marshoush varieties. In contrast, the germination rate was 90% for the Erazol variety and 80% for the Abu El Shouk variety in the control treatment. A significant decrease in germination rate was observed in all varieties with increasing salinity concentration, with the lowest germination rate recorded in the treatment with the high concentration of 200 mM. Furthermore, the Marshoush variety exhibited the highest germination rate compared to the other varieties at the 200 mM concentration.

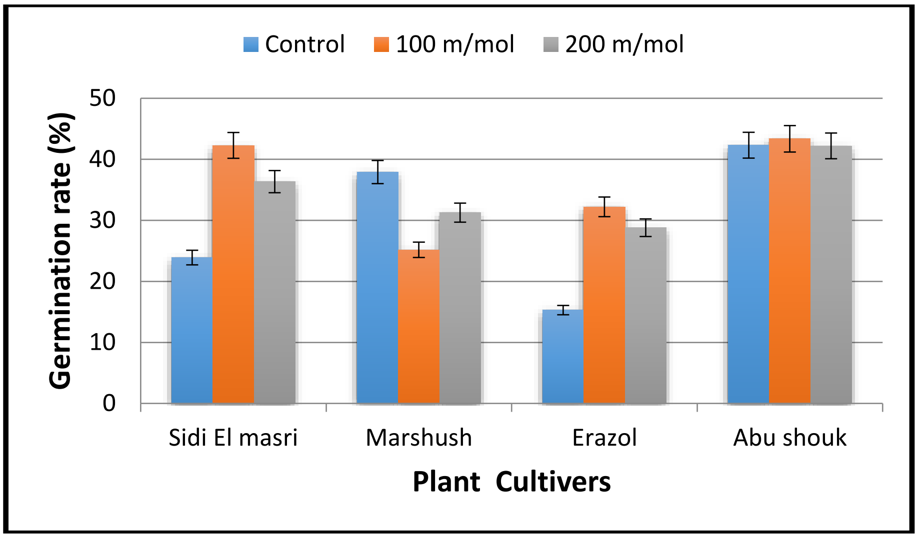

Figure (1): The effect of salinity concentrations on the germination rate of wheat varieties

The decrease in germination rates among varieties is explained by the increasing salt stress, which becomes almost nonexistent at high salinity concentrations. This is due to the toxic effect of salinity-causing ions such as sodium. Awainat M. and Hamel Kh. (2018) indicated that the accumulation of this ion within the seed affects the vital activities of the embryo and the seed. According to Hassas and Suwaida (2019), salinity reduces the germination rate of seeds, and this is directly proportional to the salinity of the medium.

Effect of Salinity on Germination Strength Index:

As shown in Figure (2), which illustrates the germination strength index, the highest germination strength was recorded in the control plants, indicating their high efficiency in biosynthesis. When applying stress at different salinity levels, a significant decrease in the germination strength index was observed in all varieties and at all salinity levels. The lowest germination strength was recorded at a concentration of 200 mM. The Sidi El Masry variety exhibited the highest germination strength compared to the other varieties, particularly at a concentration of 200 mM, while the Abu El Shouk variety recorded the lowest germination strength among the studied varieties.

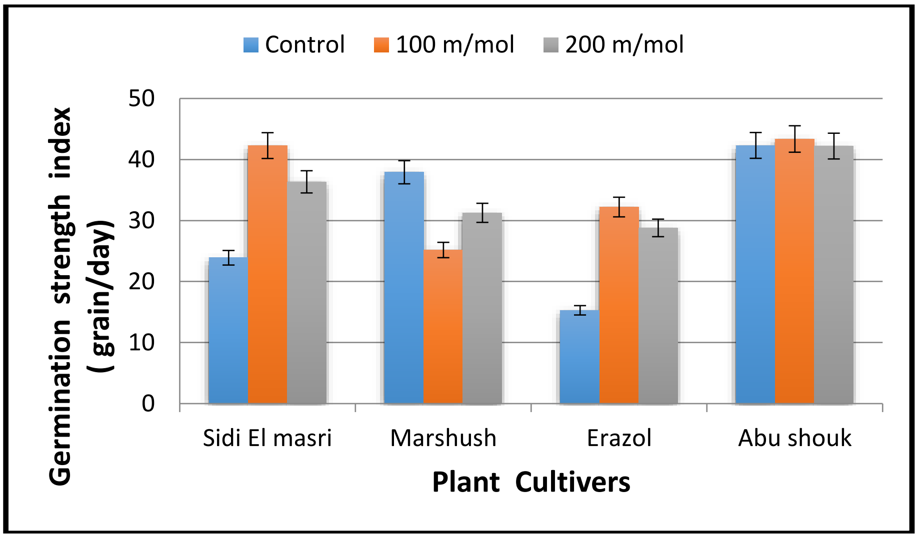

Figure (2): Effect of salinity concentrations on the germination strength index of wheat plant varieties.

The decrease in the germination strength index is explained by an increase in external osmotic pressure, which affects water absorption by the seeds, or by the accumulation of ions in the embryo. This toxic effect can alter germination metabolism and, in extreme cases, lead to embryo death due to excess ions. (Djennade N H et Attalaoui F, 2019)

Effect of salinity on proline content in leaves:

Figure (3) shows the effect of salinity concentrations on the proline content in the leaves of wheat varieties. A clear variation in proline content was observed between the wheat varieties (Sidi El Masry, Marshoush, Erazol, and Abu El Shouk). The highest concentration rate was observed in the Erazol variety at a concentration of (34.29) micrograms/100 milligrams of fresh matter, while the lowest concentration rate was observed in the Sidi El Masry variety at a concentration of (18.53) micrograms/100 milligrams of fresh matter. Regarding the effect of salinity treatments, we note that increasing the salinity concentration led to an increase in the proline content in the leaves of the plants. This was clearly observed in the Marshoush, Sidi El Masry, and Erazol varieties compared to the control .

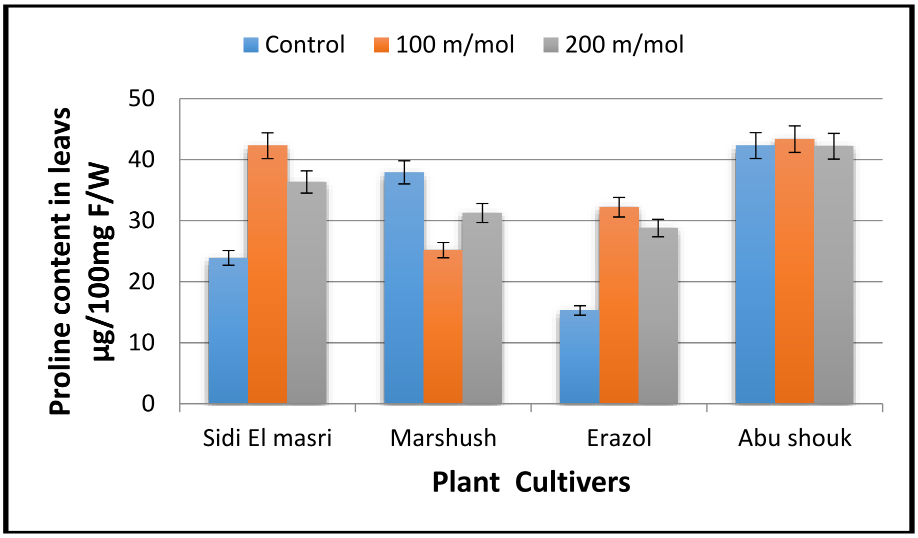

Figure (3): Effect of salinity concentrations on proline content in wheat plant varieties' leaves

The accumulation of proline in leaves is explained as one of the most prominent manifestations associated with salt stress, and as a significant response to resist salinity. Its accumulation varies from one variety to another according to salinity concentrations, and this shows a large and noticeable difference between tolerant and sensitive varieties. It also varies from one organ to another in the plant, as its value has been observed to be high at high salinity concentrations (Djerroudi et al., 2011). Thus, proline plays an effective osmotic buffering role and is key to protection against external stresses. It is also known as a limiter of salinity tolerance (Dogan et al., 2010).

Effect of salinity on sugar content in leaves:

Figure (4) shows the effect of salinity concentrations on sugar content in the leaves of wheat varieties. Significant differences in sugar content between varieties and salinity concentrations were clearly evident in favor of the Erazol and Sidi El Masry varieties, while increasing the salinity concentration did not significantly affect the Marshoush and Abu El Shouk varieties compared to the control.

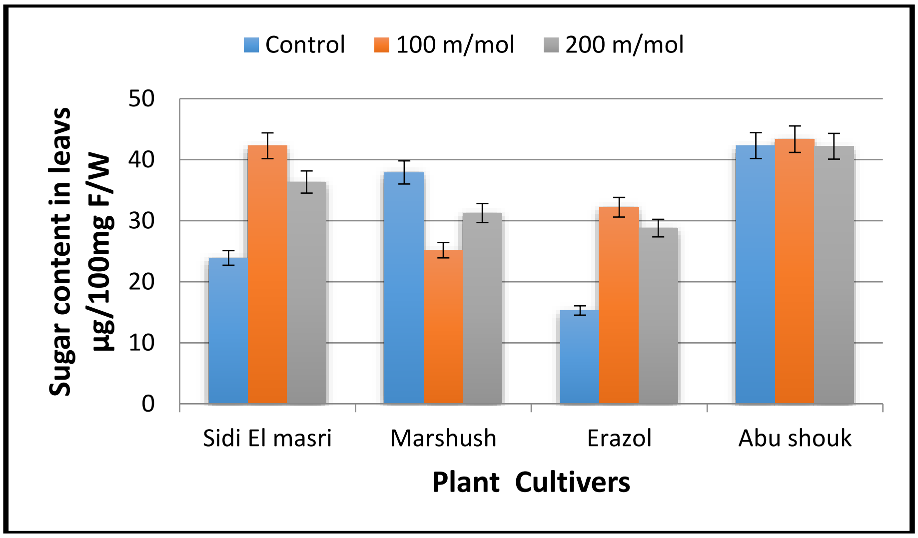

Figure (4) Effect of salinity concentrations on sugar content in wheat plant varieties' leaves.

The difference in sugar accumulation between varieties is explained by the genetic variation between varieties, as carbohydrate content is one of the important functional indicators in the plant, and its quantity in the plant gives a reflection of the degree of water stress, whether due to the salinity of irrigation water or soil. Many studies have shown that excessive salinity in the growth medium leads to a decrease in the plant's content of reducing sugars, while it leads to an increase in the content of non-reducing and soluble sugars. The accumulation of soluble and non-reducing sugars leads to an increase in the osmotic pressure of the cell sap of cells and tissues in order to equalize its osmotic pressure with the external osmotic pressure resulting from the salt stress. (Al-Abed and Bouderban, 2016).

Table (1) shows the summary of the study

Species	Cultivars	Concentration	Studies Characters			
			Germination rate (%)	Germination strength index (grein/day)	Proline content (µg/100mlg) bite substance	Sugar content (µg/100mlg) bite substance
soft wheat	Sidi El Masri	0%	100	3.16	10.09	23.9
		100%	50	1.13	26.67	42.28
		200%	45	**1.02**	18.53	36.34
	Marshoush	0%	100	3.02	10.45	37.91
		100%	50	1.27	17.4	25.17
		200%	**50**	0.48	26.18	31.26
durum wheat	Erazol	0%	90	3.13	25.34	15.29
		100%	40	0.78	18.82	32.21
		200%	10	0.17	**34.29**	28.79
	Abu El Shouk	0%	90	2.54	24.16	42.31
		100%	30	0.64	21.65	43.36
		200%	0	0	19.78	**42.2**

The results of this study are consistent with those of Zenati and Yaakoubi (2021). When three wheat genotypes (D2 and D4, representing durum wheat, and D3, representing soft wheat) were exposed to increasing concentrations of sodium chloride (0, 50, and 100 mmol), the results showed an increase in the accumulation of the amino acid proline with increasing salinity. This also aligns with the findings of Ben Jeddou and Jellabi (2021) when they studied the effect of salt stress on four oasis wheat varieties (Khalouf, Tazi, Oum Rkba, and Chater) by exposing them to three salinity concentrations (3, 9, and 14 ppm × 10^{+}3) in addition to a control. The results obtained showed that salt stress negatively affected the germination of all varieties under the different parameters studied, especially at the high concentration of 14 ppm × 10^{+}3. These results also align with those of Lahzaoula and Boulaâdham (2024), whose study exposed three durum wheat varieties (Wahbi, Bousselam, and Ain Lehma) and three soft wheat varieties (Ain Abid, Boumerzoug, and Tidis) to four salinity concentrations (0, 5, 10, and 15 g/L). This study demonstrated the negative impact of salinity on all studied morphological and physiological parameters (germination percentage, germination vigor index, average seedling length, stalk length, root length, and root count). These results are also consistent with those of Hammadi and Madhi (2021), who studied two wheat varieties, one durum wheat (Wahbi) and the other soft wheat (Massine), by exposing them to different concentrations of sodium chloride (0, 1000, 3000, and 6000 ppm) and observing their vegetative and chemical responses. The results obtained showed that increasing the salinity concentration led to a decrease in leaf area, a decrease in stem length, and a decrease in chlorophyll A-B, along with an increase in the content of proline and sugars in the leaves.

High salinity (100, 200 mmol) also led to a significant decrease in the growth of nine durum wheat varieties. The effect of salinity was most severe on root length and the wet and dry weight of the root and stem (Rashid and Ahtiwish, 2021).

Summary and Recommendations:

The germination stage is a critical and sensitive phase in plant life. It determines the plant's resistance to various environmental conditions, including salinity. Therefore, this study was conducted to investigate the effect of different salt concentrations on the germination stage and subsequent growth phases of some wheat varieties. The study revealed significant differences in the degree of salinity resistance of the varieties during the germination and vegetative growth stages. Reaching a general and definitive recommendation necessitates considering potential problems that may arise in the future during irrigation with high salinity levels, especially in field cultivation. This is crucial to avoid problems that could lead to salt accumulation in the soil surface or near the root zone, making the land unusable in the near future.

Based on these findings, it appears that the tolerance of varieties manifests through complex morphological and biochemical mechanisms. These characteristics are important and play a significant role in the selection of suitable varieties.

Therefore, we recommend the following:

1- Continued research into the effect of salinity on plant growth stages following germination, up to and including yield.
2- Conducting field trials under natural environmental conditions to study the salinity resistance of field crops, in order to select the most salt-tolerant crops for economic exploitation.

3- Expanding such studies to include different salinity concentrations.
4- Using other morphological, physiological, and biochemical parameters on the same varieties to confirm the results.

References

[1] Aouinat, Mouna, Hamel, Khawla (2018). Effect of salinity on germination and productivity of some oasis wheat varieties (blé oasiens). Master's thesis. University of El Oued.

[2] Ben Jeddou, Iman, Jellabi, Nesrine (2021). Effect of salinity on seed germination and growth of some durum wheat varieties (Triticum durum Desf.). Master's thesis. Biodiversity and Plant Physiology. Faculty of Natural and Life Sciences. University of El Oued.

[3] Djennade, N, H, ET, Attalaoui, & F. (2019) Effete de la salinité sur la germination des graines de peganum harmala , diplôme de mastre , université mohamed boudiaf m'sila p 19.22 .

[4] Djerroudi Z.O., Moulay B. et Samia H. (2010). Effect du stress salim sur l'accumulation de proline chez deux Espéces d'Atriplex halimus L. et Atriplex, canexens. European journal of scirese arch, 41(2). pp. 249-260.

[5] Dogan M., Tipirdamaz. et Dernir y. (2010). Salt resistance of tomato species grown in sand culture. Plant soil and environnement. Vol 56.p :499-507.

[6] Dubois، M ; J، Hamilon ; P، Repes and F، Smith (1956). colorimetric method for determination of sugar and related substance .Analysis . chemical..28:350-356 .

[7] El Abed, Hanane; and Boudarbane, Hanane (2016). Counteracting the effect of salinity using K_2HPO_4 on the biochemical content of durum wheat (Triticum durum Desf.) growing under salt stress. Master's thesis. Brothers Mentouri University, Constantine. pp. 6-10-12.

[8] Fercha A, Gherroucha H (2014). The role of osmoprotectants and antioxidant enzymes in the different response of durum wheat genotypes to salinity. Journal of applied botany and food quality. 87

[9] Food and Agriculture Organization of the United Nations (fao.org)

[10] Hammadi, Rayan; Madhi, Djahida (2021). Response of durum and bread wheat varieties to different levels of salinity. Master's thesis. Biodiversity and Plant Physiology. Faculty of Natural and Life Sciences. Brothers Mentouri University, Constantine.

[11] Hassas, Rania. Suwaida, Asma. (2019). A study of the effect of salinity on germination vigor in local and selected wheat varieties. Master's thesis. Department of Biology. Faculty of Natural and Life Sciences. University of Shahid Hamma Lakhdar El Oued.

[12] Lahzaoula, Nawal, Boulaâdham, Aïda (2024). Comparison of the effect of salt stress on some durum wheat varieties (Triticum durum Desf.) and bread wheat varieties (Triticum aestivu L.). Master's thesis. Plant Biotechnology. Institute of Natural and Life Sciences, Department of Biotechnology.

[13] Troll، W and J.A، Lindsey (1956) photometric method determination of proline . Journal . Bio Chemical. 216:655-661.

[14] U.S. Department of Agriculture (USDA). (2019). World Agricultural Production. International Production Assessment Division (IPAD). Washington,: Foreign Agricultural Service, Office of Global Analysis. Retrieved from

[15] https://apps.fas.usda.gov/psdonline/circulars/production.pdf

[16] Zenati, Salma, Chahinez, Yaakoubi (2021). Durum wheat (Triticum durum Desf.) response to salinity stress in the growth medium using the proline stimulant. Master's thesis. Plant Biology and Physiology. Faculty of Natural and Life Sciences. Mentouri Brothers University of Constantine.

[17] Zhang W., Chang C., Shi L., Liy. et Duo L. (2010). Alleviation of salt stress-induced inhibition of seed germination in cucumler by ethylene and gluramate. Journal of plant physiology.167 (14). 1152-1156