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CHALLENGING THE UNBEATABLE: *HELICOVERPA ARMIGERA* INFESTATION IN *MOMORDICA CHARANTIA* - A NOVEL CASE STUDY

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Abstract

Momordica charantia, commonly known as bitter gourd or bitter lemon, belongs to the Cucurbitaceae family and is a versatile herb cultivated in various tropical and subtropical regions. Despite its distinctive appearance and bitter taste, it stands out as one of the most nutritious gourds. Numerous studies have highlighted its antimicrobial properties against soilborne pathogens and inhibitory effects on human pathogens. Additionally, the plant contains compounds known to repel insect pests. In Romania, M. charantia has been successfully acclimatized at the Vegetable Research and Development Station in Buzău, leading to the development of two cultivars: Rodeo and Brâncuși. Over a span of fifteen years, this plant has demonstrated resilience, remaining free from diseases and pests that could compromise its yield. However, during the vegetation period of 2023, a notable exception occurred as researchers identified an infestation of Helicoverpa armigera in the fruit crop. Intriguingly, this pest has not been previously reported in association with bitter gourd worldwide. The existing literature does contain studies on the inhibitory effects of M. charantia compounds against H. armigera, but this case study demands further investigation.

Key words*: bitter gourd, cotton bollworm, Cucurbitaceae.*

INTRODUCTION

Bitter melon, known by various names such as bitter cucumber, bitter gourd, and karela, is a unique member of the Cucurbitaceae family, closely related to squash and cucumbers. Despite its less-than-appealing appearance and bitter taste, it stands out as one of the most nutritious and versatile vegetables, widely consumed in Southeast Asia, Indo-China (Poolperm and Jiraungkoorskul, 2017), and even in Brazil (Magalhães et al., 2019) for both culinary and traditional medicinal purposes. However, in the Western world (Basch et al., 2003), especially in countries like Romania, bitter melon dishes are not as renowned due to its distinctive taste.

The scientific name of bitter melon is *Momordica charantia* L. Delving into the etymology of the term "*momordica*", we discover its Latin origin, "*mordicus*", meaning "*biting*" (Afsar et al., 2022; Newton, 2023). This nomenclature intriguingly aligns with the grooved edges of its seeds, creating an appearance reminiscent of having been chewed. Despite its unpalatable taste, bitter melon has gained attention for its rich diversity of primary and secondary metabolites, showcasing therapeutic potential across various domains (Supe and Daniel, 2015; Bukhari et al., 2019). This unassuming vegetable proves to be a powerhouse with antiulcer properties (Gupta et al., 2011; Jia et al., 2015), antioxidant capabilities (Mala et al., 2017; Svobodova et al., 2017; Wang et al., 2017; Shafie et al., 2018), antimicrobial properties (Jia et al., 2017; Shafie et al., 2018; Zubair et al., 2018; Bukhari et al., 2019), anthelmintic prowess (Swarna and Ravindhran, 2012; Wang et al., 2016), antidiabetic potential (Jia et al., 2017; Wang et al., 2017; Peter et al., 2018; Lucas et al., 2010), anti-inflammatory attributes (Lucas et al., 2010; Peter et al., 2018), antihyperglycemic effects (Palamthodi and Lele, 2014; Jia et al., 2017; Peter et al., 2018), anticancer properties (Ji et al., 2010; Lucas et al., 2010; Wang et al., 2016; Poolperm and Jiraungkoorskul, 2017), and nutritional perks as an antilipolytic agent (Nerurkar et al., 2010; Wang et al., 2017).

The increasing global concern over bacterial resistance, predicted to be a leading cause of death by 2050 (de Kraker et al., 2016; Boklage and Lehmkuhl, 2018; Sanchez and Gustot, 2019), has thrust the spotlight on bitter melon.

In the face of bacteria becoming resistant to almost all existing antibacterials (McCarthy, 2017), the quest for novel antibacterial entities is now a global research focus (Tacconelli et al., 2018), and *M. charantia* emerges as a species holding tremendous potential. Multiple studies have highlighted its antifungal and antibacterial activity (Adeyemi et al., 2015; Supe and Daniel, 2015; Yaldiz et al., 2015), not only in the leaves (Makhija et al., 2011; Supraja and Usha, 2013; Brandão et al., 2016; Bukhari et al., 2019) but also in the fruit (Mwambete, 2009).

In various studies, *Momordica charantia* has demonstrated its potential in insecticidal prowess against a range of pests. Notably, it has exhibited effectiveness against mustard sawfly (Kumar et al., 1979), mosquitoes (Singh et al., 2006; Maurya et al., 2009; Mituiassu et al., 2021; Subramaniam et al., 2021), and common weevils, including the mung bean weevil and cowpea weevil (*Callosobruchus chinensis*; *C. maculatus*) (Ajayi, 2005; Wahyutami and Aisyah, 2022). Moreover, *Momordica charantia* has displayed insecticidal properties against aphids such as sugar cane aphids (*Melanaphis sacchari*) and mustard aphids (*Lipaphis erysimi*) (Mishra et al., 2006; Salinas-Sánchez et al., 2021).

While it's generally believed that bitter gourd's toxic compounds make it resistant to foliage pests and diseases (Robinson and Decker-Walters, 1997), our observations reveal a novel challenge - an infestation with *Helicoverpa armigera* (Hübner), commonly known as the cotton bollworm. This unexpected occurrence prompts a reassessment of bitter melon's pest resilience and introduces a new dimension to its cultivation considerations.

MATERIALS AND METHODS

The Vegetable Research Development Station in Buzau, Romania, stands as a prominent research center dedicated to the acclimatization of new plant species. Notably, since the early 2000, the research center has undertaken an acclimatization program focused on *Momordica charantia*, commonly known as bitter melon. As a result, the VRDS portfolio proudly boasts two commercially available varieties of bitter melon named Rodeo and Brâncuși (Figures 1, 2).

Figure 1. Bitter melon cultivar: Brâncuși

Figure 2. *Momordica charantia* cultivar: Rodeo

Momordica charantia is an annual, monoecious climbing plant with a cardinal taproot. The stems extend from the top of the taproot, spreading to climb any available support, necessitating the use of a trellising system. The plant features modest leaves, measuring 4-6 cm in width, with 3-7 deeply separated lobes. The pendulous fruits, characterized by 2-9 cm long stalks, typically exhibit a spindle or ellipsoid shape, appearing warty or ridged. They dehisce unevenly, resembling a 3-valved fleshy capsule. In terms of colour, the Brâncuși variety displays a white-green hue when immature, while the Rodeo cultivar takes on a dark green colour during this stage. Additionally, the Brâncuși fruit can attain lengths of up to 40 cm, whereas the Rodeo variety produces smaller fruit ranging from 10-15 cm. Notably, the Rodeo variant features more prominent ribs compared to the Brâncuși cultivar.

For the cultivation process, the cultivars were sown in the first decade of March and transplanted in the last decade of April in polytunnels. The selected planting scheme maintained a spacing of 70 cm between plants and 150 cm between rows. The obtained yield was 1.2 tons per 400 square meters. Throughout the vegetation period of 2023, diligent monitoring efforts were employed to assess and

combat potential pathogen attacks. Pathogen attacks were quantified using key indicators, including the frequency of attack (F%), intensity of attack (I%), and the degree of attack (DA%).

RESULTS AND DISCUSSIONS

Bitter gourd faces several challenges from insect pests and diseases, although none of them have been deemed significantly impactful (Robinson and Decker-Walters, 1997). In the relevant literature, the primary pests of bitter melon are typically recognized as the ladybird beetle (*Epilachna septima*), fruit borer (*Diaphania indica*), fruit fly (*Bactrocera cucurbitiae*), and red pumpkin beetle (*Aulacophora foveicollis*) (Bharathi and John, 2013). However, these pests are predominantly prevalent in Asia and Africa, not in Europe. In the European context, bitter melon cultivation may be prone to interference from the leaf miner (*Liriomyza trifolii*) and the root-knot nematode (*Meloidogyne incognita*).
In Romania, bitter gourd has exhibited tolerance to specific pathogenic attacks (Lagunovschi-Luchian et al., 2017; Bute et al., 2020). Our study aligns with this trend, as we observed minimal interference from the leaf miner, with the primary interaction being with *Meloidogyne incognita*. Although the frequency of attack occurred over 33.7% of the crop surface, and the intensity of the attack ranged from mild to medium, it did not result in significant yield losses (Figure 3).

Figure 3. Nematode infestation on *M. charantia* roots

Disease resistance is a crucial trait in bitter gourd cultivation due to its potential to significantly reduce both yield and quality. The escalating use of chemicals for pest and disease management raises apprehensions among growers about both economic viability and human health (Kole et al., 2020).
Globally, *Fusarium* wilt (*Fusarium oxysporum* f. *niveum*) is the most prevalent disease in bitter gourd crops. *Fusarium* wilt, caused by *Fusarium oxysporum*, is a common and destructive soil-borne disease affecting cucurbit crops worldwide. Additionally, anthracnose (*Colletotrichum lagenarium*), powdery mildew (*Sphaerotheca fuliginea*), downy mildew (*Pseudoperonospora cubensis*), and fruit rot (*Pythium aphanidermatum*) contribute to significant foliar and yield losses in bitter melon crops (Bharathi and John, 2013). In Romania, sporadic anthracnose attacks were observed, with a frequency of 35.7%, intensity at 10%, and a degree of attack at 3.6% (Bute et al., 2020). At VRDS Buzau, no diseases affecting yield or fruit quality have been recorded.
The atypical weather patterns of 2023, amidst the broader context of climate change, witnessed heatwaves during the summer leading to an increase in pest activity, notably *Helicoverpa armigera*, commonly known as the cotton bollworm. Towards the end of August 2023, sporadic attacks on bitter melon fruits by *Helicoverpa armigera* were noted after a period of pest-free conditions (Figures 4 and 5).

Figure 4: *Helicoverpa armigera* infestation on bitter melon fruit

The sporadic infestations noted towards the end of August 2023 were attributed to the third to sixth instar of the second-generation larvae of *Helicoverpa armigera*. Regarding the established indicators frequency of attack (F%), intensity of attack (I%), and the degree of attack (DA%) these metrics were determined based on the activities of the aforementioned third to sixth instar larvae of *Helicoverpa armigera*.

Figure 5. Bitter melon fruit and cross-section under *Helicoverpa armigera* attack

The frequency of attack was recorded at 12.3%, with variations in intensity observed among different cultivars. Notably, Brâncuși exhibited higher susceptibility (7.1%) compared to Rodeo (5.48%). The degree of attack ranged from 6.4% (Rodeo) to 8.6% (Brâncuși).

It is crucial to emphasize that these indicators provide insights into the behavior and impact of the specific generation of *Helicoverpa armigera* larvae under investigation. Importantly, the cotton bollworm demonstrated a distinctive trait by exclusively targeting the fruits, leaving the leaves unaffected.

Despite the unexpected nature of these occurrences, the persistence, virulence, and ongoing impact of the attacks warrant further study in subsequent years. This exploration aims to discern whether the observed trend in 2023 was a singular event influenced by the heatwaves or indicative of a continuing pattern.

Worldwide, *M. charantia* is extensively studied for its undeniable benefits. In Romania, while this plant is not as common, recent studies are increasingly recommending its cultivation for both crops and medicinal purposes.

Notably, in Romania, pests and diseases do not pose a significant threat, emphasizing the importance of maintaining the crop's current status.

To address potential pest and disease issues in *Momordica* cultivation in Romania, it is crucial to implement thorough crop monitoring and utilize cultivars with high tolerance. Moreover, imposing restrictions on the import of fruits susceptible to various plant pathogens and diseases becomes essential. It is worth noting that the European Union has established specific import requirements for bitter melon fruits from Sri Lanka, Thailand, Honduras, and Mexico. These requirements emphasize the necessity for produce originating from pest-free areas or those with comprehensive physical protection. The stipulations also highlight the importance of implementing multiple measures throughout the production, handling, and inspection processes (Official Journal of the European Union, 2022).

In Romania, we have *Momordica* cultivars, including Brâncuși and Rodeo, renowned for their robust yield potential and excellent adaptation to the local pedoclimatic conditions. The cultivation of these varieties not only proves to be viable but also offers substantial advantages for farmers.

CONCLUSIONS

Momordica charantia, though less common in Romania, has been gaining attention for both agricultural and medicinal purposes. Pest and disease management, particularly in the face of an emerging threat from *Helicoverpa armigera*, underscores the need for vigilant crop monitoring and the adoption of tolerant cultivars. Notably, local cultivars like Brâncuși and Rodeo showcase high yield potential and adaptability to the local pedoclimatic conditions, making them not only viable, but also advantageous choices for Romanian farmers. The impact of climate change, exemplified by heatwaves in 2023, further emphasizes the importance of ongoing research to understand and address evolving challenges in *Momordica* cultivation.

REFERENCES

Adeyemi AO, Adeyinka AV, Olawande FT. (2015). Antibacterial activities of aqueous extracts of *Terminalia catappa*, *Momordica charantia* and *Acaiypha wilkesiana* on *Escherichia coli* isolated from pediatrics. Pak j sci ind res Ser B biol sci.;58(2):72-6.

Afsar A, Riaz H., Hadayat U., Jawad A., Shahab A. Khan, Khitab U., Fawad A., Suliman K., Mehboob A., Osama R., Waleed A., Fawad K., Shahab A. (2023) - Management of major insect pest of bitter gourd (*Momordica charantia*) through different pesticides.

Journal of Xi'an Shiyou University, Natural Science Edition, 403-411.
Ajayi, O. E. (2015). Toxicity and repellent activity of *Momordica charantia* (L.) extracts against the Cowpea Weevil, *Callosobruchus maculatus* (Fab) (Coleoptera: Chrysomelidae). Jordan Journal of Agricultural Sciences, 11(3).
Basch E, Gabardi S, Ulbricht C. (2003). Bitter melon (*Momordica charantia*): A review of efficacy and safety. Am J Heal Sys.t Pharm; 60(4):356-359.
Bharathi, L. K., & John, K. J. (2013). Momordica genus in Asia-An overview (p. 25-29). New York: Springer.
Boklage E., Lehkuhl M. (2018). Coverage of antimicrobial resistance in the German Press: 1993-2013. Heal Commun.; 34(9):958-63.
Brandão D.O., Guimarães G.P., Santos R.L., Júnior F.J.L.R., da Silva K.M.A., de Souza F.S., (2016). Model analytical development for physical, chemical, and biological characterization of *Momordica charantia* vegetable drug. J Anal Methods Chem.:15 pages
Bukhari S.A., Farah N., Mustafa G., Mahmood S., Naqvi S.A.R. (2019). Magneto-priming improved nutraceutical potential and antimicrobial activity of *Momordica charantia* L. without affecting nutritive value. Appl Biochem Biotechnol.;188(3):878-892.
Bute, A., Ambăruș, S., Brezeanu, C., Călin, M., & Brezeanu, P. M. (2020). The study of tolerance of some species and varieties of cucurbitaceae to the attack of pathogens. Scientific Studies & Research. Series Biology/Studii si Cercetari Stiintifice. Seria Biologie, 29(2).
de Kraker M., Stewardson A., Harbarth S. (2016). Will 10 million people die a year due to antimicrobial resistance by 2050? PLoS Med. 2016;13(11):1-6.
Gupta M., Sharma S., Gautam A., Bhaduria R. (2011). *Momordica charantia* Linn. (Karela): Nature's silent healer. Int J Pharm Sci Rev Res.; 11(1):32-7.
Jia S., Shen M., Zhang F., Xie J. (2017). Recent advances in *Momordica charantia*: Functional components and biological activities. Int J Mol Sci.;18(12):1-25.
Ji H, Zhang L, Li J, Yang M, Liu X., (2010). Optimization of ultrahigh pressure extraction of momordicosides from bitter melon. Int J Food Eng.; 6(6): Article 3.
Jurnalul Oficial al Uniunii Europene - https://eur-lex.europa.eu/legalcontent/RO/TXT/HTML/?uri=CELEX%3A32022R0853
Kole, C., Matsumura, H., & Behera, T. K. (Eds.), (2020). The bitter gourd genome. Cham Switzerland: Springer.
Kumar Arun., Tewari, G. D. and Panday, N. D., (1979). Studies on antifeeding and insecticidal properties of bitter gourd (*Momordica charantia* Linn.) against mustered saw fly Athalia proxima Klug. Pesticides, 13(12): 9.
Lagunovschi-Luchian, V., Vinatoru, C., Zamfir, B., Bratu, C., Tăpăloagă, D., & Radoi, I. (2017). Studies and research regarding acclimatization and breeding of new vegetable plant, *Momordica charantia* at VRDS Buzău, România. The EuroBiotech Journal, 1(1), 82-84.
Lucas EA, Dumancas GG, Smith BJ, Clarke SL, Arjmandi BH., (2010). Health benefits of bitter melon (*Momordica charantia*). In: Watson RR, Preedy VR, editors.Bioactive Foods in Promoting Health. San Diego: Academic Press; p. 525-49.
Magalhães KDN, Guarniz WAS, Sá KM, Freire AB, Monteiro MP, Nojosa RT, (2019). Medicinal plants of the Caatinga, northeastern Brazil: Ethnopharmacopeia (1980-1990) of the late professor Francisco José de Abreu Matos. J Ethnopharmacol; 237:314-53.
Makhija M, Ahuja D, Nandy BC, Gautam S, Tiwari K, Awasthi A, (2011). Evaluation and comparison of antibacterial activity of leaves, seeds and fruits extract of *Momordica charantia*. Res J Pharm Biol Chem Sci.; 2(2):185-92.
Mala M, Hepsibah AH, Jothi GJ., (2017). Silver nanoparticles synthesis using *Coccinia grandis* (L.) voigt and *Momordica charantia* L, its characterization and biological screening. J Bionanosci.;11(6):504-13.
Maurya, P., Sharma, P., Mohan, L., Batabyal, L., & Srivastava, C. N. (2009). Evaluation of larvicidal nature of fleshy fruit wall of *Momordica charantia* Linn. (family: Cucurbitaceae) in the management of mosquitoes. Parasitology research, 105, 1653-1659.
McCarthy M., (2017). Woman dies after infection with bacteria resistant to all antibiotics available in US. BMJ.; 356:j254.
Mituiassu, L. M. P., Serdeiro, M. T., Vieira, R. R. B. T., Oliveira, L. S., Maleck, M. (2021). *Momordica charantia* L. extracts against *Aedes aegypti* larvae. Brazilian Journal of Biology, 82, e236498.
Mishra, D., Shukla, A. K., Dubey, A. K., Dixit, A. K., & Singh, K. (2006). Insecticidal activity of vegetable oils against mustard aphid, *Lipaphis erysimi* Kalt., under field condition. Journal of Oleo Science, 55(5), 227-231.
Mwambete KD. (2009). The in vitro antimicrobial activity of fruit and leaf crude extracts of *Momordica charantia*: A Tanzania medicinal plant. Afr Heal Sci. 2009;9(1):34- 9.
Nerurkar P V., Lee YK, Nerurkar VR. (2010). *Momordica charantia* (bitter melon) inhibits primary human adipocyte differentiation by modulating adipogenic genes. BMC Complement Altern Med.; 10:34
Newton, L. E. (2023). Momordica Cucurbitaceae. In Dicotyledons: Rosids (pp. 251-257). Cham: Springer International Publishing.
Palamthodi S, Lele SS. (2014). Nutraceutical applications of gourd family vegetables: *Benincasa hispida, Lagenaria siceraria* and *Momordica charantia*. Biomed Prev Nutr.; 4(1):15-21
Peter EL, Kasali FM, Deyno S, Mtewa A, Nagendrappa PB, Tolo CU (2018). *Momordica charantia* L. lowers elevated glycaemia in type 2 diabetes mellitus patients: Systematic review and meta-analysis. J Ethnopharmacol.; 231:311-24
Poolperm S, Jiraungkoorskul W. (2017). An update review on the anthelmintic activity of bitter gourd, *Momordica charantia*. Pharmacogn Rev; 11(21):31-4.
Robinson RW, Decker-Walters DS (1997) Cucurbits. CAB International, Wallingford, Oxford, UK
Salinas-Sánchez, D. O., Ramírez-Rodríguez, R., Rivas-González, J. M., Figueroa-Brito, R., Peña-Chora, G., Toledo-Hernández, E., Sotelo-Leyva, C. (2021). Chemical composition of *Ricinus communis* and

Momordica charantia seeds extracts and its bioactivity against the sugarcane aphid, *Melanaphis sacchari* (Zehntner). International Journal of Tropical Insect Science, 1-6.

Sanchez LO, Gustot T. (2019). Multidrug-resistant bacterial infection in patients with cirrhosis. A review. Curr Hepatol Rep.;18(1):28-35.

Shafie MH, Samsudin D, Yusof R, Gan C-Y. (2018). Characterization of bio-based plastic made from a mixture of *Momordica charantia* bioactive polysaccharide and choline chloride/glycerol based deep eutectic solvent. Int J Biol Macromol.; 118(Part A):1183-92

Singh, R. K., Dhiman, R. C., & Mittal, P. K. (2006). Mosquito larvicidal properties of *Momordica charantia* Linn (family: Cucurbitaceae). Journal of Vector Borne Diseases, 43(2), 88.

Subramaniam, J., Murugan, K., Kovendan, K. (2012). Larvicidal and pupcidal efficacy of *Momordica charantia* leaf extract and bacterial insecticide, *Bacillus thuringiensis* against malarial vector, *Anopheles stephensi* Liston (Diptera: Culicidae). Journal of Biopesticides, 5, 163.

Supe U, Daniel P. (2015) HPLC method for analysis of bioactive compound from *Momordica charantia*. Am J Agric Environ Sci.; 15(11):2196-200.

Supraja P, Usha R. (2013). Antibacterial and phytochemical screening from leaf and fruit extracts of *Momordica charantia*. Int J Pharm Bio Sci. 2013;4(1):787-93.

Svobodova B, Barros L, Calhelha RC, Heleno S, Alves MJ, Walcott S (2017). Bioactive properties and phenolic profile of *Momordica charantia* L. medicinal plant growing wild in Trinidad and Tobago. Ind Crop Prod.; 95:365-73.

Swarna J, Ravindhran R. (2012). *Agrobacterium rhizogenes* - mediated hairy root induction of *Momordica charantia* Linn. and the detection of charantin, a potent hypoglycaemic agent in hairy roots. Res J Biotechnol;7(4):227-31.

Tacconelli E, Carrara E, Savoldi A, Harbarth S, Mendelson M, Monnet DL (2018). Discovery, research, and development of new antibiotics: the WHO priority list of antibiotic-resistant bacteria and tuberculosis. Lancet Infect Dis.; 18(3):318-27.

Wahyutami, C. T., & Aisyah, S. N. (2022). Insecticidal Activity of Bitter Melon (*Momordica charantia* L.) Leaf Extract on Mung Bean Weevil (*Callosobruchus chinensis* L.). In IOP Conference Series: Earth and Environmental Science (Vol. 985, No. 1, p. 012053). IOP Publishing.

Wang S, Zheng Y, Xiang F, Li S, Yang G. (2016). Antifungal activity of *Momordica charantia* seed extracts toward the pathogenic fungus *Fusarium solani* L. J Food Drug Anal.; 24(4):881-7.

Wang S, Li Z, Yang G, Ho CT, Li S. (2017) *Momordica charantia*: A popular healthpromoting vegetable with multifunctionality. Food Funct.; 8(5):1749-62.

Yaldiz G, Sekeroglu N, Kulak M, Demirkol G. (2015). Antimicrobial activity and agricultural properties of bitter melon (*Momordica charantia* L.) grown in northern parts of Turkey: A case study for adaptation. Nat Prod Res.;29(6):543-5.

Zubair MF, Atolani O, Ibrahim SO, Oguntoye OS, Abdulrahim HA, Oyegoke RA (2018). Chemical and biological evaluations of potent antiseptic cosmetic products obtained from *Momordica charantia* seed oil. Sustain Chem Pharm.; 9:35-41