International Journal of Engineering Inventions
e-ISSN: 2278-7461, p-ISSN: 2319-6491
Volume 15, Issue 4 [April 2026] PP: 35-39

Sustainable management of mango, pineapple and avocado wastes – some valorization highlights: an updated overview

Vanya Zhivkova[1*]
[1]*University of Economics – Varna, blvd "Knyaz Boris I" 77, 9002 Varna, Bulgaria*

Abstract. *This updated overview paper aimed to present some current, contemporary valorization highlights regarding the sustainable management of mango, pineapple and avocado wastes. In this regard, a search was conducted using relevant keywords only in the Scopus database and only research scientific publications were selected, as the author did not intend to summarize all available and accessible literature on the topic. There is a persistent trend to seek ways for the effective valorization and utilization of mango, pineapple and avocado wastes. A review of the scientific literature revealed that numerous and diverse studies are being conducted aimed at transforming these waste fruit substances into a potential raw material resource. Achieving sustainability is a top priority in research.*

Date of Submission: 01-04-2026 Date of acceptance: 10-04-2026

I. Introduction

In previous publications on fruit waste valorization, the author examined opportunities for mango and avocado waste utilization [1], as well as some current aspects of pineapple waste utilization [2]. The intention of the aforementioned works was to periodically supplement, expand and update the latest research trends and valorization aspects regarding the sustainable utilization of fruit waste [1, 2]. In this regard, the aim of the current updated overview paper is to present some of the new, contemporary highlights in the sustainable management of mango, pineapple and avocado wastes, concerning their valorization.

II. Materials and Methods

In order to fulfill the aim, a search was made using relevant keywords in the scientific database Scopus, only research scientific publications were selected, review articles and book chapters were not included. As in other works, so in this paper, the author wishes to emphasize that the study does not present a bibliographic description of the entire scientific output.

III. Results and Discussion

3.1 Sustainable valorization of mango wastes

As in previous works, and in this updated overview paper, the author believes that it is appropriate for the cited research articles to be systematized according to the content of some key terms in their titles. For publications on mango waste valorization used here, such terms presented in Table 1 are: *"waste/wastes"*, *"peel/peels"*, *"seed"*, *"sustainable"*, *"utilization"*, *"valorization"*, *"kernel"*, *"residue"*.

Table 1. Basic terms in publications' titles and some valorization highlights on mango wastes.

Key terms	Mango wastes valorization highlights	Reference
"waste"	biochar	[3]
"waste"	mulch films	[4]
"wastes"	breweries wastewater	[5]
"peel", *"waste"*	As(III) scavenging	[6]
"peel", *"waste"*	antioxidant activity	[7]

* Corresponding author: v_jivkova@abv.bg

"utilization", *"seed"*, *"waste"*	edible coating biomaterials	[8]
"valorization", *"kernel"*, *"waste"*	analysis of different mango kernel	[9]
"peel"	silage	[10]
"peel"	soluble dietary fibers	[11]
"peel", *"sustainable"*	sourdough bread	[12]
"peel"	hydrocolloids – food emulsions	[13]
"peel"	physicochemical characterization	[14]
"peels"	physicochemical marker	[15]
"peels"	encapsulation	[16]
"seed"	dietary fibre	[17]
"*kernel*"	starch – packaging materials	[18]
"kernel", *"residue"*	biochar composite – Cr(VI) adsorption	[19]

The research trends highlighted in [1] related to the effective valorization and utilization of mango wastes while pursuing circular sustainability goals are being further developed and enriched. In the relevant cited scientific publications (Table 1), various methods, analyses used, and quantitative data from the results obtained are described.

3.2 Sustainable valorization of pineapple wastes

Regarding pineapple waste, the following terms are noticeable in the titles of the publications cited in this paper: *"waste"*, *"peel"*, *"sustainable"*, *"utilization"*, *"management"*, *"by-products"*, *"valorization"* (Table 2).

Table 2. Basic terms in publications' titles and some valorization highlights on pineapple wastes.

Key terms	Pineapple wastes valorization highlights	Reference
"waste"	drying kinetics	[20]
"waste"	bioactive compounds	[21]
"waste"	syngas	[22]
"sustainable", "utilization", "waste"	regenerated cellulose	[23]
"waste"	dye biodegradation	[24]
"waste"	bioethanol	[25]
"waste"	biogas	[26]
"peel", *"waste"*	solid-state fermentation	[27]
"peel", *"waste"*	energy	[28]
"management", *"peel"*, *"waste"*	polyphenols – pakchoi soft rot	[29]
"by-products", *"sustainable"*, *"waste"*	bromelain	[30]
"peel", *"sustainable"*	chitosan	[31]
"peel"	edible coatings	[32]
"peel"	dried peel powder – crackers	[33]

"peel"	acetic acid bacterial strain	[34]
"valorization", *"by-products"*	by-products extracts – coffee phenolics – combination with milk	[35]

The utilization aspects regarding pineapple wastes, identified in the previous review of scientific articles, and noted in [2], show a steady trend of continuation and further development in the current updated overview. Sustainable pineapple waste management emphasizes the implementation of integrated circular approaches, which are the basis for successful and effective valorization. A detailed justification of the scientific methodology used, as well as quantitative data on the research results, can be found in the scientific publications cited here (Table 2).

3.3 Sustainable valorization of avocado wastes

From the publications selected here on avocado waste, key terms can be identified in the titles as follows: *"waste"*, *"peel/peels"*, *"seed/seeds"*, *"biorefinery"*, *"sustainable"*, *"valorization"*, *"circular"*, *"residues"*, *"by-products"* (Table 3).

Table 3. Basic terms in publications' titles and some valorization highlights on avocado wastes.

Key terms	Avocado wastes valorization highlights	Reference
"waste"	activated bioadsorbent	[36]
"sustainable", *"waste"*	bioelectricity generation	[37]
"waste", *"peels"*	catalyst – biodiesel	[38]
"peel", *"biorefinery"*, *"sustainable"*, *"valorization"*, *"waste"*	bioactive compounds	[39]
"seed", *"waste"*	activated carbon – Cr(VI) and Mn(II) removal	[40]
"sustainable", *"waste"*, *"seeds"*	Cr(VI) adsorption	[41]
"peel"	catechins	[42]
"peels"	peels drying and characterization	[43]
"seed", *"peel"*	adsorption of Cd, Hg, Ni, Pb	[44]
"seed"	Pulsed electric field extraction	[45]
"seed"	seed starch-based films	[46]
"seed"	seed powder – adsorbent	[47]
"seeds"	seeds – drying and characterization	[48]
"circular", *"seeds"*	adsorbents – onboard storage of natural gas	[49]
"residues"	procyanidins extraction	[50]
"residues", *"sustainable"*, *"valorization"*	phenolic compounds extraction	[51]
"by-products"	biodegradable films	[52]

As with the other two fruit wastes considered here, and with avocado waste, precise quantitative data can be found in the relevant cited scientific papers, the commenting and comparison of which is not the subject of this updated paper. The various valorization directions marked in Table 3 show that the trend for sustainable treatment of avocado wastes, which was noted in [1], continues to develop.

IV. Conclusions

It can be concluded that in this updated overview paper, the study conducted among current scientific publications proves the relevance and importance of the issue under consideration regarding the sustainable

valorization of fruit waste, whose representatives are mango, pineapple and avocado wastes, respectively. Research into the sustainable utilization of mango, pineapple and avocado wastes is numerous and intensive, and this trend is evident in the diverse research directions for the effective management of the aforementioned fruit wastes.

References

[1]. V. Zhivkova, E3S Web of Conferences **548**, 01005 (2024)
[2]. V. Zhivkova, BIO Web of Conferences **146**, 01029 (2024)
[3]. M. Hareem, S. Danish, S. Al Obaid, M.J. Ansari, R. Datta, Scientific Reports **14**, 14270 (2024)
[4]. M.A. Lorenzo Santiago, J.R. Rendón Villalobos, S.M. Contreras Ramos, G. Pacheco Vargas, E. García Hernández, Recycling **9(5)**, 96 (2024)
[5]. Y.M. Kouotou, A. Njoya, I.C. Mountapbeme, S. Njuhou, P.S. Kamgang, M. Mouafon, D. Njoya, D. Njopwouo, International Journal of Ceramic Engineering & Science **6(5)**, e10229 (2024)
[6]. D. Gyawali, S. Poudel, M. Poudel, K.N. Ghimire, M.R. Pokhrel, P. Basnet, B.K.K. Bahadur, H. Paudyal, Heliyon **10(16)**, e36496 (2024)
[7]. R.A. Indriyanti, Y. Kharisma, M.M. Damayanti, Pharmacognosy Journal **16(5)**, 1010-1014 (2024)
[8]. H. Harahap, A.P. Galatea, R.R.E. Gultom, Halimatuddahliana, A. Yustira, M.H.S. Ginting, E3S Web of Conferences **560**, 02012 (2024)
[9]. R.M. El-Shabasy, T.F. Eissa, Y. Emam, A. Zayed, N. Fayek, M.A. Farag, Scientific Reports **14**, 2886 (2024)
[10]. K.T. Aung, K.S. Win, K.S. Mu, M. Aung, Y.Y. Kyawt, Animal – Open Space **3**, 100069 (2024)
[11]. S. Bhatt, M. Gupta, Sustainable Food Technology **2**, 1506-1516 (2024)
[12]. M.E. Chulibert, P. Roppolo, C. Buzzanca, A. Alfonzo, E. Viola, L. Sciurba, I. Tinebra, A. D'Amico, V. Farina, D. Piazzese, V. Di Stefano, M. Barbera, R. Gaglio, L. Settanni, Antioxidants **13(11)**, 1278 (2024)
[13]. R. Marsiglia-Fuentes, J.M. Franco, L.A. García-Zapateiro, Applied Food Research **4(2)**, 100582 (2024)
[14]. A.A. Pacheco-Jiménez, J. Lizardi-Mendoza, J.B. Heredia, E.P. Gutiérrez-Grijalva, E.A. Quintana-Obregón, M.D. Muy-Rangel, Heliyon **10(15)**, e35184 (2024)
[15]. P. Chaiwan, P. Rachtanapun, Y. Phimolsiripol, W. Ruksiriwanich, C. Li, L. Luo, D. Shen, H.-H. Chung, D. George, T. Tangpao, S.R. Sommano, P. Sunanta, Horticulturae **10(10)**, 1036 (2024)
[16]. N. Kučuk, M. Primožič, Ž. Knez, M. Leitgeb, Foods **13(15)**, 2404 (2024)
[17]. L.S. Guan, S.F. Pasaribu, M.S. Rabeta, B. Akter, A. Ghazali, Food Research **8(4)**, 343-350 (2024)
[18]. G.P. Singh, S.P. Bangar, K. Aayush, T. Yang, R. Verma, K. Kuca, D. Kumar, Y. Phimolsiripol, International Journal of Biological Macromolecules **274**, 133185 (2024)
[19]. Y. Zhang, Y. Tang, R. Yan, S. Liang, Z. Liu, Y. Yang, Chinese Journal of Chemical Engineering **71**, 91-101 (2024)
[20]. M.E. Cavalcanti-Mata, M.E. Duarte, M. Tolentino, F.A. Mendes, L. Batista, J.M. de Lima, A. Lúcio, A.P. Nascimento, R.D. Almeida, H.M. Lisboa, Processes **12(6)**, 1198 (2024)
[21]. F. de Andrade Maia, L.H. Fasolin, The Journal of Supercritical Fluids **218**, 106455 (2025)
[22]. D. Dermawan, D.-W. Tsai, G.S. Yudoyono, S.-J. You, Y.-K. Hsieh, Renewable Energy **231**, 120962 (2024)
[23]. J. Kumar, I. Alam, A. Kumar, A. Kumar, S.K. Singh, S.P. Singh, C. Sharma, Biomass and Bioenergy **182**, 107068 (2024)
[24]. J.-R. Lee, J.C. Jalani, Z.I. Mohd Arshad, J.C.S. dos Santos, S.K.A. Mudalip, S. Md Shaarani, S.Z. Sulaiman, Journal of Advanced Research in Applied Sciences and Engineering Technology **35(2)**, 1-10 (2024)
[25]. S.T. Mgeni, L.A. Mtashobya, J.K. Emmanuel, Heliyon **10(19)**, e38172 (2024)
[26]. V.A. Rabinovich, C. Linnenberg, U. Theilen, H. Weigand, Fermentation **10(5)**, 261 (2024)
[27]. A.D. Casas-Rodríguez, J.A. Ascacio-Valdés, M.D. Dávila-Medina, M.A. Medina-Morales, L. Londoño-Hernández, L. Sepúlveda, Applied Microbiology **4(2)**, 934-947 (2024)
[28]. W.-H. Chen, L.-X. Liu, H.-K. Sheen, A.B. Culaba, K.S. Khoo, S. Lim, Fuel **372**, 132275 (2024)
[29]. Y. Zhou, Z. Tan, Journal of Environmental Chemical Engineering **12(6)**, 114342 (2024)
[30]. P.G. Chiarelli, B. Martinez, T. Nakamura, K. Mis Solval, Foods **13(4)**, 589 (2024)
[31]. D. Davis, M. Umesh, A.S. Santhosh, S. Suresh, S. Shanmugam, T. Kikas, Polymers **16(17)**, 2455 (2024)
[32]. M.B.F. Galvão, T.C.M. Stamford, F.A.B.R. de Melo, G.S. de Lima, C.E.V. de Oliveira, I.L.N. de Oliveira, R.d.C.d.A. Bidô, M.M.E. Pintado, M.E.G. de Oliveira, T.L.M. Stamford, Foods **13(18)**, 2873 (2024)
[33]. T. Mala, S. Piayura, P. Itthivadhanapong, Future Foods **9**, 100322 (2024)
[34]. Y. Selvanathan, N.H. Abdul Manas, N. Zainol, N. Masngut, Food Bioscience **62**, 105198 (2024)
[35]. Z.B. Kocakaplan, G. Ozkan, S. Kamiloglu, E. Capanoglu, Plant Foods for Human Nutrition **79**, 300-307 (2024)
[36]. S. Orozco, L.B. López-Sosa, E. Montiel, J. Espino, R. Guerra, J. Vargas, I. Alfonso, M. Rivero, Results in Engineering **24**, 103347 (2024)
[37]. S. Rojas-Flores, J. Vives-Garnique, F. Díaz, M. De La Cruz-Noriega, Processes **12(4)**, 715 (2024)
[38]. A.O. Etim, P. Musonge, Catalysts **14(4)**, 261 (2024)
[39]. J.F. Grisales-Mejía, G. Álvarez-Rivera, M.M. Andrade-Mahecha, H.A. Martínez-Correa, J.A. Mendiola, A. Cifuentes, E. Ibañez, LWT – Food Science and Technology **214**, 117119 (2024)
[40]. K. Mabalane, N.D. Shooto, P.M. Thabede, Case Studies in Chemical and Environmental Engineering **10**, 100782 (2024)
[41]. M.E. Mahmoud, G.F. El-Said, G.A.A. Ibrahim, A.A.S. Elnashar, Biomass Conversion and Biorefinery **14**, 14725-14743 (2024)
[42]. D.L. Restrepo-Serna, C.A. Cardona-Alzate, Sustainable Chemistry and Pharmacy **39**, 101556 (2024)
[43]. N.C. Santos, R.L.J. Almeida, S.S. Monteiro, E.W.V. de Andrade, R. dos Santos Silva, J.C. Albuquerque, D.V.P. de Figueiredo, D.R. Duarte, L.d.S.S. Pinheiro, A.N.A. Martins, S.d.N. Silva, R.A.d.L. Dias, M.A.d.B. Pasquali, A.P.T. Rocha, Chemical Engineering and Processing-Process Intensification **205**, 110004 (2024)
[44]. A. Gómez-Naranjo, C. Mayorga-Naranjo, P.Y. Vélez-Terreros, G.S. Yánez-Jácome, A. Oviedo-Chávez, H. Navarrete, J. Vinueza-Galáraga, D. Romero-Estévez, Applied Sciences **14(23)**, 10851 (2024)
[45]. N. Faizah, W. Widiyastuti, H. Setyawan, T. Nurtono, Industrial Crops and Products **222**, 119803 (2024)
[46]. P.F. Muñoz-Gimena, A. Aragón-Gutiérrez, E. Blázquez-Blázquez, M.P. Arrieta, G. Rodríguez, L. Peponi, D. López, Polymers **16(20)**, 2868 (2024)
[47]. T.P. Sahoo, G. Satasiya, P.G. Moradeeya, H.T. Saravaia, M.A. Kumar, Environmental Research **261**, 119727 (2024)
[48]. D.D. Fufa, T. Bekele, A. Tamene, G. Bultosa, Heliyon **11(1)**, e41058 (2025)
[49]. T.J. Riwa, S.J. Mushi, M.M. Madirisha, P.E. Mabeyo, E.C. Mapunda, Next Materials **5**, 100256 (2024)

[50]. M.d.C. Razola-Díaz, J. Genovese, U. Tylewicz, E.J. Guerra-Hernández, P. Rocculi, V. Verardo, LWT – Food Science and Technology **212**, 116952 (2024)
[51]. J.F. Grisales-Mejía, V. Cedeño-Fierro, J.P. Ortega, H.G. Torres-Castañeda, M.M. Andrade-Mahecha, H.A. Martínez-Correa, G. Álvarez-Rivera, J.A. Mendiola, A. Cifuentes, E. Ibañez, Separation and Purification Technology **351**, 128104 (2024)
[52]. J.F. Grisales-Mejía, H.A. Martínez-Correa, M.M. Andrade-Mahecha, Food and Bioproducts Processing **148**, 154-164 (2024)