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Research paper

Evaluation of Physico-Chemical Properties of Biocompost: Insights into its Quality and Applications

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ABSTRACT

Biocomposting, the process of decomposing organic waste through microbial activity, offers a sustainable approach to waste management while producing valuable compost for agricultural and environmental applications. This study evaluates the physico-chemical properties of biocomposts derived from different organic materials. The compost samples were analyzed for parameters such as moisture content, pH, electrical conductivity, organic carbon, nitrogen, phosphorus, potassium, and trace elements. The results revealed significant variations in the physico-chemical composition, influenced by the type of organic material used and the composting process. The quality of the biocompost was found to be suitable for enhancing soil fertility, improving plant growth, and promoting sustainable agricultural practices. This paper provides insights into the potential applications of biocompost as an eco-friendly alternative to chemical fertilizers.

1. Introduction

The exponential growth of the global population has placed unprecedented demands on agricultural systems to meet rising food security needs. Traditional agricultural practices, primarily dependent on synthetic agrochemicals, have achieved remarkable increases in crop productivity but at a significant cost to environmental health and sustainability. Over time, the excessive and imbalanced use of chemical fertilizers has led to soil degradation, reduced microbial diversity, water contamination, and nutrient imbalances, posing serious threats to ecosystem stability and human health (Armstrong et al., 2017; Dominguez et al., 2011). This calls for a paradigm shift toward sustainable agricultural practices that maintain productivity while preserving the ecological balance.

Effective Microorganisms (EM) technology offers an innovative and eco-friendly solution to these challenges. EM consists of a mixed culture of beneficial microorganisms, including lactic acid bacteria, yeast, actinomycetes, and photosynthetic bacteria, which can improve soil structure, nutrient availability, and plant growth when applied to agricultural fields. Recent studies have demonstrated that EM inoculation can significantly enhance soil microbial diversity, suppress pathogens, and promote nutrient cycling, thereby fostering a healthy and sustainable soil ecosystem (Han et al., 2006; Khan et al., 2021). These microorganisms also facilitate the decomposition of organic matter, converting it into humus, which provides essential nutrients and hormones for plants while improving soil moisture retention (Yamada & Xu, 2001; Chakraborty et al., 2015).

The reliance on chemical fertilizers since the Green Revolution has undoubtedly revolutionized global food production, contributing to an estimated 40-60% increase in crop yields (Zhang & Tian, 2021). However, the long-term impacts of these practices, including soil fertility depletion, nutrient leaching, and reduced microbial activity, have raised concerns about their sustainability (Gao et al., 2024). Excessive fertilizer use has also been linked to the contamination of water bodies, leading to ecological imbalances and public health risks (Omar et al., 2020). Recent findings suggest that a reduction in chemical fertilizer dependency, coupled with the adoption of organic and microbial solutions, can mitigate these negative effects while ensuring sustainable agricultural productivity (Foley et al., 2011; Matlok et al., 2020).

Composting is another sustainable approach gaining prominence for its ability to recycle organic waste into nutrient-rich fertilizer. The process involves the decomposition of organic matter by beneficial microorganisms, resulting in a stabilized product that improves soil fertility, enhances nutrient cycling, and reduces greenhouse gas emissions. Advanced composting techniques, including thermophilic and mesophilic stages, have been shown to efficiently eradicate pathogens, transform organic waste into humus, and minimize waste accumulation (Habtamu et al., 2023; Nayaka & Bhushan, 2019). These techniques are particularly critical in addressing the growing concerns surrounding solid waste management and its environmental impacts.

Solid waste management is integral to environmental sustainability and agricultural resilience. It involves the systematic control of waste generation, collection, processing, and disposal, with a focus on recycling and nutrient recovery. The integration of solid waste management into agricultural practices not only reduces environmental hazards but also recycles valuable nutrients into soil systems, enhancing their fertility and productivity (Adejumo & Adebiyi, 2020). Recent studies underscore the importance of adopting holistic waste management strategies that combine composting, EM technology, and reduced chemical fertilizer usage to promote sustainable agriculture (Kuehnelt et al., 2003; Cai et al., 2013).

This research study explored the synergistic potential of effective microorganisms, composting, and integrated solid waste management in addressing the challenges of modern agriculture. It highlights their roles in improving soil health, promoting sustainable food production, and mitigating the adverse impacts of synthetic agrochemicals. By emphasizing the importance of these practices, the study contributes to the broader discourse on achieving climate-resilient and ecologically sustainable agricultural systems for the future.

2. Objectives

- To collect biocompost samples from the Nagercoil Municipal Corporation for comprehensive analysis.
- To evaluate the physico-chemical properties of the collected biocompost, including pH, electrical conductivity, and nutrient content (nitrogen, phosphorus, potassium, and calcium) and compare with relationship.
- To assess the potential of municipal biocompost as an organic fertilizer for sustainable agricultural practices.
- To explore the variability in nutrient composition among different biocompost samples and identify factors influencing their quality.
- To provide recommendations for optimizing biocompost use in enhancing soil fertility and crop productivity.

3. Materials and Methods

3.1 Collection of Biodegradable Wastes (Organic Wastes)

Organic waste materials, including food waste, fruit peels, vegetable scraps, flower waste, meat and fish remains, eggshells, and garden waste, were collected from Nagercoil City Corporation. These materials were processed through a mechanical shredder to reduce them into smaller fragments. The fragmented waste was then placed into twelve drying tanks, where it was weighed before being transferred. The waste in the tanks was turned daily to facilitate uniform drying, which was achieved over a period of 40–45 days. This step ensured optimal conditions for the decomposition process.

3.2 Addition of Effective Microorganisms (EM) Solution

Two weeks after the initial drying process, an Effective Microorganisms (EM) solution was added to the decomposing organic waste. The EM solution, prepared using curd, ash, sugar, and water, introduced a consortium of microbes to enhance the breakdown of organic matter. To manage the gaseous emissions, including methane and carbon dioxide, a series of ventilation pipes were incorporated into the system, allowing for controlled release of gases generated during the decomposition process.

3.3 Production of Biocompost

Once the drying and decomposition processes were completed, the partially decomposed waste was subjected to grinding using a specialized machine. This process further homogenized the material, resulting in fine biocompost. The final product was then packaged and made available for consumers. Alternatively, dried organic waste collected from households could directly be processed in machines to produce biocompost (Fig. 1).

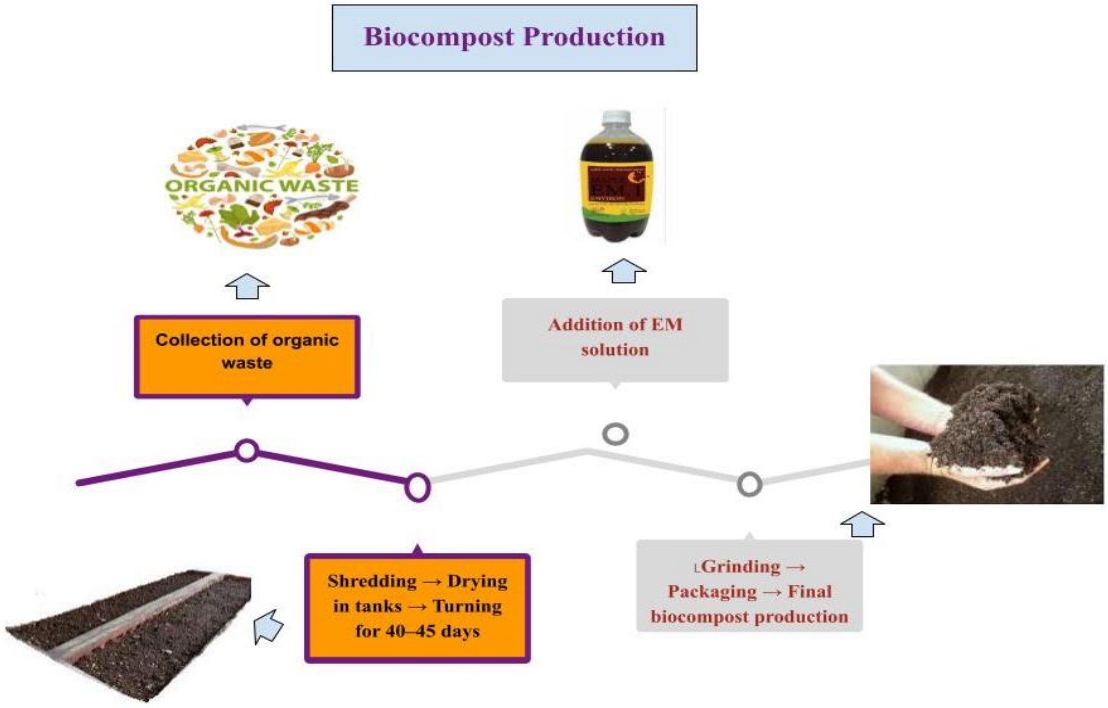

Fig. 1 An overview of the production of biocompost

3.4 Management of Non-Biodegradable Wastes

Non-decomposable wastes such as polybags, glass, thermocol, paper, cardboard, iron pieces, old clothes, wood, rubber, leather materials, and electronic waste were collected and segregated at the municipal storage facility. Hazardous materials, including paints, pesticides, sanitary napkins, oil barrels, used and damaged electrodes, blades, syringes, and medical waste, were also collected and incinerated under controlled conditions to ensure safe disposal. Non-biodegradable waste such as thermocol, old clothes, and polybags were further processed by burning and used in cement manufacturing industries, thereby promoting waste recycling and reuse.

1. Collection of non-biodegradable and hazardous waste → Segregation at the municipal facility.
2. Incineration of hazardous waste → Recycling of thermocol and polybags in cement manufacturing.

3.5 Data analysis

The data compares different between values at the $p< 0.05$ level. Pearson correlation coefficient was used

for analysis through software to determine the strength and direction of relationship between variable. P- values 0.05 indicates statically significant.

4. Results and Discussion

4.1 Texture of Biocompost

The texture of the biocompost was consistent across all samples, characterized as sandy loam. This texture is ideal for ensuring good aeration and drainage, which are crucial for soil health and plant growth.

4.2 Psysico-chemical properties

Prepared samples using the aerobic method were analyzed for various physico- chemical properties. EC, pH, Nitrogen, Phosphorus, Potassium and Ca CO3 values of all samples are displayed in Table 1.

The calcium carbonate content in the biocompost was moderate (0.17), indicating balanced soil pH and contributing to nutrient availability. This level is ideal for calcium carbonate and is suitable for enhancing the soil's structural integrity. The electrical conductivity (EC) ranges from 2.20–2.40 dS/m, suggesting a moderate concentration of soluble salts, which is optimal for plant growth as it helps in nutrient availability while preventing salt toxicity. The average pH of the biocompost was 8.03, which indicates a slightly alkaline nature, which is suitable for a wide range of plants, especially those thriving in higher pH soils, and supports nutrient availability. The average nitrogen content of the biocompost was 33.53 kg/acre. Nitrogen is a key nutrient for plant growth, promoting healthy leaf and stem development, improving soil fertility and promoting vigorous plant growth. The average phosphorus content was 52.5 kg/acre, which is crucial for root development, flowering and fruiting, enhancing soil fertility and supporting healthy crop yield. The average potash content is 500 kg/acre, considered very high. Potassium is vital for plant health, improving resistance to diseases, drought, and enhancing overall vigor, making this biocompost highly effective in providing essential nutrients for plant growth.

Table 1 Psysico-chemical properties of the biocompost samples

	EC (mS/cm)	pH	Nitrogen (Kg/Acre)	Phosphorus (Kg/Acre)	Potassium (Kg/Acre)	$CaCO_3$ (Kg/Acre)
Sample 1	2.20	7.4	33	52	400	0.15
Sample 2	2.30	8.2	33.5	53	600	0.17
sample 3	2.40	8.5	34.1	52.5	500	0.2
Average	2.30	8.03	33.53	52.5	500	0.17
SD	0.1	0.56	0.55	0.5	100	0.02
SE	0.05	0.32	0.31	0.28	57.7	0.014

4.3 Relationship

The relationship between parameters and biocompost growth of non-biodegradable wastes was analysed using Pearson's Correlation showing a significant positive correlation ($P < 0.05$) between electrical conductivity (EC), pH, nitrogen, phosphorus, potassium, and $CaCO_3$ among the physico-chemical properties of the collected biocompost, as shown the Fig. 2.

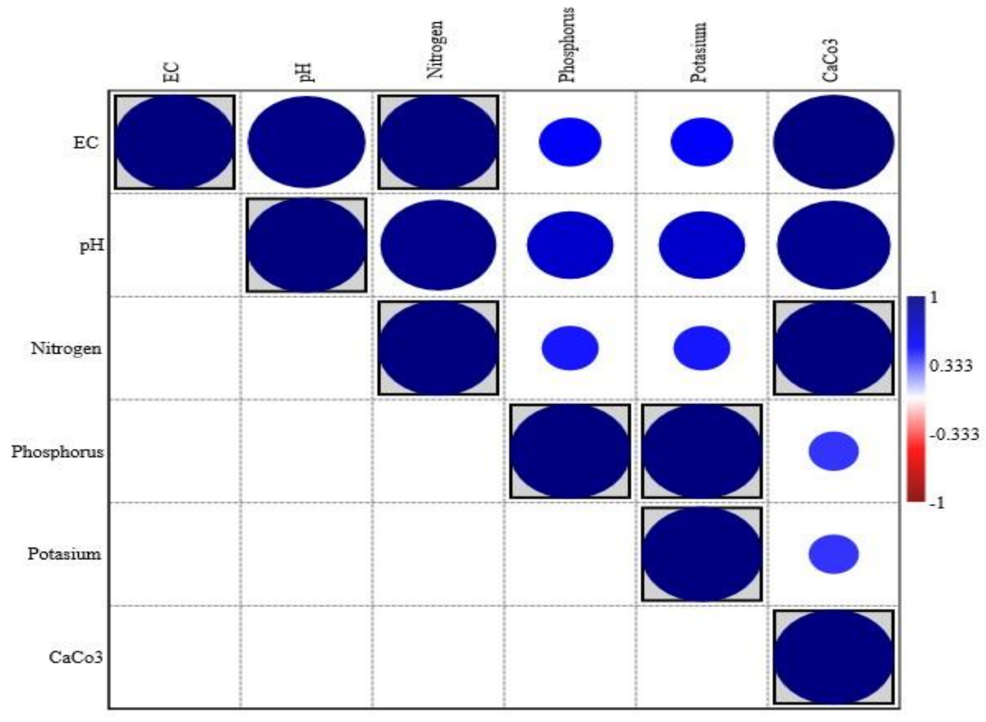

Fig. 2 Pearson's correlation analysis of the different parameters

4.4 Properties and Soil Benefits of Biocompost

The biocompost produced in this study exhibited a sandy loam texture, which is ideal for enhancing soil aeration and drainage. This texture is beneficial for plant root growth, facilitating optimal water retention and nutrient uptake (Tisdall & Oades, 1982). The moderate calcium carbonate content in the compost ensures a balanced pH, contributing to a stable soil environment and promoting nutrient availability for plants. With an alkaline pH of 8.0, the compost is suitable for plants that thrive in slightly higher pH soils, further supporting its potential for improving soil fertility (Panpatte et al., 2019).

The biocompost also exhibited a high potassium content (500 kg/acre), which is essential for improving plant resistance to diseases, drought, and promoting overall plant health (Marschner, 2012). Nitrogen and phosphorus levels (33.5 kg/acre and 52.5 kg/acre, respectively) were also sufficient to enhance soil fertility and promote healthy plant growth (Khan et al., 2006). The electrical conductivity (2.30 dS/m) was within an optimal range, indicating that the biocompost provides balanced salt levels that do not inhibit plant growth (Marschner, 2012).These findings highlight the potential of biocomposting as an effective method for recycling organic waste while producing a nutrient-rich soil amendment that enhances soil health and supports sustainable agricultural practices.

4.5 Role of Effective Microorganisms (EM)

Effective Microorganisms (EM) play a crucial role in accelerating the decomposition of organic matter and enhancing nutrient cycling. The inclusion of microorganisms like photosynthetic bacteria, nitrogen-fixing bacteria, and fungi in the EM solution helps break down complex organic compounds into bioavailable forms, thus enriching the soil with essential nutrients (Higa & Parr, 1994). These microbes also facilitate the transformation of organic waste into valuable compost, which is beneficial for improving soil fertility.

Moreover, EM has been shown to suppress soil-borne pathogens, thereby promoting healthier soil ecosystems. The beneficial microorganisms in EM, including lactic acid bacteria, work through competitive exclusion to inhibit the growth of harmful pathogens. Lactic acid bacteria have been specifically noted for their ability to reduce nematode populations, which helps prevent nematode-related plant diseases and further improve soil health (Higa, 2000; Magdoff & van Es, 2009).

4.6 Enhanced Crop Quality and Yield

The use of EM in composting not only accelerates the decomposition process but also enhances crop quality and yield. Studies have demonstrated that EM improves soil structure and fertility, resulting in better soil aeration, root development, and overall plant health. As a result, crops grown with EM-amended compost often show increased yields, improved grain quality, and better nutritional profiles (Higa & Parr, 1994). For example, vegetable crops treated with EM have been shown to have higher nutritional content, such as increased vitamin and mineral levels (Jing et al., 2010).

Additionally, EM's role in enhancing soil microbial diversity and promoting plant growth has made it a popular tool for sustainable farming practices, providing an eco-friendly alternative to chemical fertilizers (Magdoff & van Es, 2009).

4.7 Environmental Benefits

The environmental benefits of using EM and biocomposting are significant. By promoting the decomposition of organic waste, EM reduces the need for harmful waste disposal methods, such as burning or landfill use. This not only helps in reducing the environmental impact of organic waste but also prevents harmful emissions, such as methane, from accumulating in landfills (Jing et al., 2010). Furthermore, the application of EM reduces foul odors commonly associated with composting facilities, creating a more environmentally friendly and socially acceptable composting process (Higa & Parr, 1994). Biocomposting, as facilitated by EM, also plays a critical role in reducing the environmental burden of agricultural practices by offering a sustainable solution for waste recycling. By utilizing organic waste to create biocompost, we contribute to a circular economy that enhances soil health, reduces pollution, and promotes sustainable agricultural practices (Jing et al., 2010).

5. Conclusion and Recommendations

5.1 Benefits of Bio Compost

Soil: Improves physical structure, enriches with microorganisms, enhances water holding capacity, and attracts beneficial earthworms.
Plant Growth: Boosts germination, root development, and crop yield by enriching soil with microorganisms.
Economic: Reduces landfill waste, creates rural jobs, and is cost-effective for less-developed agricultural regions.
Environmental: Reduces greenhouse gas emissions, helps recycle waste on-site, and is low-maintenance.

5.2 Uses of Bio Compost

It enhances soil fertility by adding organic matter and nutrients, improving moisture retention. It can be mixed other materials to create loam or tilled directly into the soil. Additionally, it helps eliminate pathogens, weeds, and unwanted seeds promoting healthily plant growth.

Biocomposting at Nagercoil was a challenging but useful experiment that produced healthy soil in a highly sought after area. Our research showed that the hot aerated approach is effective in producing a profitable compost that is suitable for EC, pH, Nitrogen, Phosphorus, Potassium and Ca CO3 and contains various microbes that can break down trash. In conclusion, bio-composting is a simple, cost-effective process that transforms organic waste into valuable fertilizer, benefiting both the environment and agriculture.

6. References

Adejumo, I. O., & Adebiyi, O. A. (2020). Agricultural solid wastes: causes, effects, and effective management. *Strategies of sustainable solid waste management*, *8* (10.5772).

Armstrong, C.G., Shoemaker, A.C., McKechnie, I., Ekblom, A., Szabó, P., Lane, P.J., McAlvay, A.C., Boles, O.J., Walshaw, S., Petek, N. and Gibbons, K.S., 2017. *Anthropological contributions to historical ecology:* 50 questions, infinite prospects. *PloS One*, *12*(2), p.e0171883. DOI: 10.1371/journal.pone.0171883

Cai, T., Park, S. Y., & Li, Y. (2013). Nutrient recovery from wastewater streams by microalgae: status and prospects. *Renewable and Sustainable Energy Reviews*, *19*, 360-369. DOI: 10.1016/j.rser.2012.11.030

Chakraborty, U., Chakraborty, B., Dey, P., & Chakraborty, A. P. (2015). Role of microorganisms in alleviation of abiotic stresses for sustainable agriculture. In *Abiotic stresses in crop plants*. Wallingford UK: Cabi. pp. 232-253. DOI: 10.1079/9781780643731.0232.

Dominguez, J., Hanley, R. L., & Paoletti, M. G. (2011). Impact of synthetic fertilizers on soil microbial activity and nutrient cycling. *Soil Biology and Biochemistry,* 43(8), 1670-1678.

Foley, J. A., Ramankutty, N., Brauman, K. A., Cassidy, E. S., Gerber, J. S., Johnston, M., ... & Zaks, D. P. (2011). Solutions for a cultivated planet. *Nature*, *478*(7369), 337-342. DOI: 10.1038/nature10452.

Gao, S., Dong, Y., Jia, Q., Wu, S., Bai, J., Cui, C., ... & Liu, H. (2024). Hazards of toxic metal (loid) s: Exploring the ecological and health risk in soil–crops systems with long-term sewage sludge application. *Science of The Total Environment*, p. *948*, 174988. DOI: 10.1016/j.scitotenv.2024.174988.

Habtamu, M., Elias, E., & Argaw, M. (2023). Effects of Integrated Soil Fertility Management Practices on Soil Properties under Wheat and Faba Bean Production in Dire and Legedadi Watersheds of Ethiopia.

Han, S. H., Shin, J. H., Kim, H. Y., & Oh, K. H. (2006). Effect of effective microorganisms (EM) on crop productivity and soil health. *Applied Soil Ecology,* 34(1), 20-26.

Higa, T. (2000). Effective microorganisms in the context of Kyusel Nature Farming-a technology for sustainable agriculture and environmental management. p. 42- 47.

Higa, T., & Parr, J. F. (1994). Beneficial and effective microorganisms for a sustainable agriculture and environment. Atam*i, Japan: International Nature Farming Research Center. Vol. 1, pp. 16-16.*

Jing, J., & Ming-Hua, S. O. N. G. (2010). Review of the roles of plants and soil microorganisms in regulating ecosystem nutrient cycling. *Chinese Journal of Plant Ecology*, *34*(8), 979.

Khan, A., Malik, Z., & Shafiq, M. (2021). Enhancing soil fertility through effective microorganisms: A review. *Agriculture and Natural Resources,* 55(1), 121-130.

Khan, M. M., Zaman, M., & Gul, R. (2006). Impact of bio-compost on soil fertility and crop growth*. Soil Science Society of America Journal,* 70(2), 1345-1354.

Kuehnelt, D., Goessler, W., & Francesconi, K. A. (2003). Nitrogen purity influences the occurrence of As+ ions in high-performance liquid chromatography/electrospray ionization mass spectrometric analysis of four common arsenosugars. *Rapid communications in mass spectrometry*, *17*(7), 654-659. DOI: 10.1002/rcm.963

Magdoff, F., & Van Es, H. (2009). Building Soils for Better Soil: Sustainable Soil Management, Chapter 4: *The Living Soil.* pp. 42-48.

Marschner, P. (2012). Rhizosphere biology. In Marschner's mineral nutrition of higher plants. *Academic Press.* pp. 369-388. DOI: 10.1016/B978-0-12-384905-2.00015-7

Matlok, N., Szostek, K., & Nowakowski, K. (2020). Fertilizers and food security: Trends and challenges. *Agricultural Sciences Review,* 8(3), 210-225.

Nayaka, A., & Bhushan, B. (2019). An overview of the recent trends on the waste valorization techniques for food waste. *Journal of Environmental Management*, *233*, 352-370. DOI: 10.1016/j.jenvman.2018.12.041

Omar, L., Ahmed, R., & Patel, S. (2020). Environmental risks of fertilizer use in modern agriculture. *Environmental Science Advances,* 7(2), 45-60.

Panpatte, D.G. and Jhala, Y.K. eds., 2019. *Soil fertility management for sustainable development*. Springer. p. 25-42.

Tisdall, J. M., & OADES, J. M. (1982). Organic matter and water-stable aggregates in soils. *Journal of soil science*, *33*(2), 141-163. DOI: 10.1111/j.1365-2389.1982.tb01755.x.

Yamada, K., & Xu, H. L. (2001). Properties and applications of an organic fertilizer inoculated with effective microorganisms. *Journal of Crop production*, *3*(1), 255-268. DOI: 10.1300/J144v03n01_21.

Zhang, D., & Tian, Q. (2021). A Novel Fuzzy Optimized CNN-RNN Method for Facial Expression Recognition. *Elektronikair Elektrotechnika*, *27*(5), 67-74.DOI: 10.5755/j02.eie.29648.