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**The Thesis Submitted for the Degree of Ph. D in the field of
wood Composite products**

**The investigation of decreasing of
formaldehyde gas emission from
particleboard produced from urea
formaldehyde adhesive with plant
extracts additive**

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Abstract

The aim of this research was to reduce the release of formaldehyde and improve the physical and mechanical wood particleboard obtained from urea-formaldehyde adhesive by using the addition of extracts of different plants such as *Sansevieria*, *Chlorophytum* and *Aglaonema*. plant Extraction of plant leaves was done and on two levels, 5% and 10% was added to the urea formaldehyde adhesive of Samed Mashhad and Shiraz factory as an additive. The physico-chemical characteristics of the mentioned adhesive, including the solids content, gelation time, pH, density, and the amount of free formaldehyde, were measured before and after adding the extracts. MALDI ToF, FTIR and TGA tests were performed so as to identify the possible chemical structures and in order to check the components of the adhesive and the extract, the bonds and intensity of the reactions and the thermal behavior of the obtained adhesives. Then the particle boards were made with pure urea-formaldehyde adhesive and urea-formaldehyde adhesive mixed with different extracts, and the physical properties (water absorption and thickness swelling), mechanical properties (internal bonding, modulus of elasticity and modulus of rupture) and the amount of their formaldehyde emission was measured according to the relevant standards. Based on the results of physico-chemical characteristics, the formation of multiple hydrogen bonds between the active ingredients of the adhesive and the extract led to an increase in intermolecular forces and an increase in the internal strength of the adhesive. As a result, the amount of free formaldehyde of the adhesive decreased. It can be attributed significant improvement of resistance to the object obtained from adhesives containing extract to the quality of transverse connections and the increase in the density of the adhesive. The probable chemical structures of the reaction of some active compounds of the extract with urea-formaldehyde adhesive were confirmed by MALDI ToF mass spectrum. Based on the results of the FTIR spectrum, the addition of the extracts weakened the absorption intensity of the urea formaldehyde adhesive peaks; this indicates that the active groups in the extracts reduced the formation of chemical bonds, including methylene and ether bonds in the adhesive. Also, TGA results showed that the plant extracts addition to urea-formaldehyde adhesive slightly increased the thermal degradation temperature indicating the higher thermal stability of combined adhesives compared to pure urea-formaldehyde adhesive. According to the results, by adding the amount of extract from 5 to 10 percent, the amount of formaldehyde emission of the boards decreased. It also showed that, in general, by increasing the amount of extract of *Sansevieria*, *Chlorophytum* and *Aglaonema* from 5 to 10 percent, the mechanical properties of the boards increased and their physical properties improved. The formation of stronger communication bridges and a network of transverse hydrogen connections create stronger connections between wood particles, and as a result, mechanical and physical properties are improved. The scanning electron microscope (SEM) images confirmed this matter. The obtained results showed that the highest reduction in formaldehyde emission is related to the boards made from urea-formaldehyde adhesive of Shiraz factory with 10% addition of *Sansevieria* extract to wood particle, which showed a 75.24% reduction compared to the control sample.

Keywords: Wood Particleboard, Ureaformaldehyde Adhesive, plant extract, Mechanical and Physical Properties, Formaldehyde Emission