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Application of field-cycling NMR relaxometry to determination of molecular dynamic processes in vegetable oils and oil seeds

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Field-cycling (FC) proton nuclear magnetic resonance (1H NMR) relaxometry was applied to study dynamic properties of a molecular system composed of whole oil seeds and independently of oil molecules extracted from the seeds. In the case of the neat oil, the 1H NMR relaxation dispersion curves (i.e. relaxation profiles), expressed by single relaxation times measured as a function of Larmor frequencies, were interpreted as a superposition of intramolecular and intermolecular contributions to the overall relaxation. These two contributions are modulated in time, respectively, by rotational and translational dynamics of the oil molecules, therefore applying proper theoretical models, it was possible to obtain information on rotational and/or translational molecular parameters (i.e., correlation times) of the molecules in the neat oil. In the case of oil seeds' investigations, the field-cycling NMR relaxometry was especially successfully used in the differentiation among the solid (i.e., carbohydrates, proteins, or fats forming a solid form of lipids) and liquid-like (oil compounds) components of the seeds. Thus, the two spin-lattice relaxation times were measured as a function of frequencies for the whole seeds under investigation that can be related to the solid (with the shorter T1) and liquid-like component (with the longer T1). For the interpretation of the solid components, a characteristic power-law frequency dependence of the proton relaxation dispersion was used, whereas the analysis of the liquid-like components was similar to that applied to the molecules of the oil extracted from the seeds. Because NMR techniques are totally non-destructive, the proposed investigations can be considered in terms of the use of the FC NMR relaxometry for authentication purposes of different oils and/or their adverse modifications within the production process.