26TH BALTPHARM FORUM

STUDENT POSTER PRESENTATION ABSTRACTS

IMPACT OF POWDER FLOW PROPERTIES ON PRINTABILITY IN DIRECT POWDER EXTRUSION 3D PRINTING

MARIJA BLOCKYTĖ, JURGA ANDRĖJA KAZLAUSKAITĖ, JURGA BERNATONIENĖ
Marija.blockyte@stud.lsmu.lt

Pharmaceutical Technology Institute, Lithuanian University of Health Sciences (LSMU)
Address: Sukileliu pr. 13, Kaunas, LT-50106, Lithuania

Introduction: Direct powder extrusion is a promising additive manufacturing technique in pharmaceutical technology that enables one-step production of dosage forms by feeding powder directly into the printer head. In contrast to filament-based systems, DPE does not rely on a filament to drive material flow, making powder flow a crucial parameter for regulating continuous movement through the screw mechanism and ensuring the uniformity of printed dosage forms.

Study aim: To evaluate the impact of powder flow properties on printability in Direct Powder Extrusion 3D printing

Methods: Three polymer-based formulations were prepared using PEG 4000, HPC, and Kollidon VA 64, with magnesium stearate as a lubricant. Evaluation of powder flow properties was performed according to the European Pharmacopoeia 11th Edition, including bulk density, tap density, and angle of repose, to further characterise flow behaviour. Selected powders underwent a processing step, including manual grinding and granulation, to assess their impact on material feeding, extrusion stability, and printability

Results: Powder flow properties varied among the tested formulations. Formulation 2, containing 10% PEG 4000, 30% HPC, 59% Kollidon VA 64, and 1% magnesium stearate, demonstrated the most favourable flow behaviour, characterised by a low compressibility index of ≤10% and a Hausner ratio of 1.11, which enabled continuous material feeding, stable extrusion, and successful tablet formation. In contrast, Formulation F1 exhibited a compressibility index of approximately 18% and a Hausner ratio of approximately 1.22, indicating poor flow properties and resulting in irregular material feeding and unstable extrusion. The third formulation had moderate flow characteristics, but extruded only under a stationary position, preventing consistent tablet formation.

All formulations exhibited a low angle of repose, indicating favourable flow behaviours.

Additionally, grinding the powder in a mortar and pestle resulted in unsuccessful printing, suggesting that finer particles increased powder cohesion and negatively affected material feeding.

Conclusions: A clear relationship between powder flow properties and printability was observed in DPE 3D printing. The findings emphasise that the physical characteristics of the feedstock, shaped by powder processing, significantly influence extrusion stability and material performance. These results highlight the need to control powder properties to ensure reliable and consistent DPE-based manufacturing.

SAFE DISPOSAL BINS FOR UNWANTED MEDICINES

MARIANN HENDRIKSON, MART MAIDE, MAARJA MÕTUS
mariann.hendrikson@artun.ee

Estonian Academy of Arts
Address: Põhja puiestee 7, Tallinn 10412, Estonia

Introduction: The safe disposal of unwanted medicines is an important environmental and public health issue. Expired or unused medicines are often discarded in household waste or flushed into sewage systems, where they can contaminate soil and drinking water. Although pharmacies are legally required to accept unwanted medicines, the disposal process is not always clear, visible, or convenient for the public. This project aimed to improve the accessibility, clarity, and quality of the safe disposal of unwanted medicines, while also supporting pharmacies' everyday workflow.

Method: In collaboration with Estonian pharmacies, public authorities (Ministry of Social Affairs, Agency of Medicines, Ministry of Climate) and a waste management partner (Ragn-Sells Estonia) and city of Pärnu two pharmaceutical waste collection modules in different sizes (S and M) were developed at Estonian Academy of Arts to fit pharmacy environments and comply with waste-handling regulations. The modules were designed to integrate into pharmacy environments, comply with waste-handling regulations, and enable the independent and guided safe disposal of unwanted medicines. The system supported the separate sorting of medicinal products, sharp waste, and paper/cardboard packaging. A six-week pilot was conducted in 19 pharmacies in the city of Pärnu. During this period, feedback was collected from pharmacists and residents, and quantitative data on collected waste volumes were monitored.

Results: The pilot demonstrated a significant improvement in disposal practices. The volume of unwanted medicines collected increased approximately three times compared to the same period previously - 382 kg of waste was collected during the six weeks. In addition, the quality of sorting improved: less packaging was mixed with medicinal waste, and sharps were more consistently separated.

All participating pharmacies reported that the module was convenient, practical, and well-suited to their premises. Eighteen out of nineteen pharmacies expressed their willingness to continue using the module for the safe disposal of unwanted medicines.

Conclusion: The pilot project showed that a clear, accessible, and user-friendly collection system can substantially improve both the rate and quality of the safe disposal of unwanted medicines. By preventing hazardous substances from entering the environment and by supporting pharmacy workflows, the solution demonstrates strong potential for further development into a scalable national or international system.

VARIATIONS IN THE CONTENT OF PHENOLIC COMPOUNDS AND MARRUBIIN IN MARRUBIUM VULGARE L. INFLUENCED BY CLIMATIC AND GEOGRAPHICAL CONDITIONS

MANTAS JUODIS1, LIUDAS IVANAUSKAS, OLHA MYKHAILENKO
mantas.juodis@stud.lsmu.lt

Department of Analytical and Toxicological Chemistry, Lithuanian University of Health Sciences (LSMU)
Address: Sukileliu pr. 13, Kaunas, LT-50106, Lithuania

Introduction: Common horehound (*Marrubium vulgare* L.) is a plant of the *Lamiaceae* family, native to the Mediterranean and Central Asian regions, though it is currently spread worldwide. Climatic conditions, geographical location, and altitude significantly influence the biosynthesis and accumulation of this plant's secondary metabolites, particularly phenolic compounds and marrubiin [2]. In the European Pharmacopoeia (Ph. Eur.), the monograph White horehound (*Marrubii herba*; 01/2019:1835) for plant quality control is regulated based on its primary bio active compound, the labdane-type diterpene marrubiin, the content of which in the dried raw material must be no less than 0.7% [3]. Marrubiin is considered the main chemotaxonomic marker of the *Marrubium* genus and it, possess anti-inflammatory, analgesic, antidiabetic, and vasorelaxant effects [4]. The aim of this study is to evaluate the variation in the content of phenolic compounds and marrubiin in raw material of different geographical origin and to determine the climatic and geographical factors influencing this variation.

Method: The herb *Marrubium vulgare* L. used for the study was collected in Ukraine (Lviv) in 2020–2024 and in Lithuania (Simaiciai and Klaipeda) in 2025, during the flowering period. The total phenolic was determined by the Folin-Ciocalteu spectrophotometric method, and the marrubiin content was evaluated using the High-Performance Liquid Chromatography (HPLC). Statistical data analysis was performed using the "IBM SPSS Statistics 31.0.0.0" software package, calculating Spearman's correlation coefficient. Results were considered statistically significant when $p < 0,05$.

Results: The marrubiin content in the Ukrainian samples varied from 0.85 ± 0.02% to 1.15 ± 0.05% (the highest content was in 2020, the lowest in 2024). The content in Lithuania samples was lower: 0.78 ± 0.02% in Simaiciai and 0.72 ± 0.02% in Klaipeda. All samples complied with the Ph. Eur. standard of > 0.7%. The phenolic compounds content in the Ukrainian samples varied from 2.147 to 5.365 ± 0.013 GRE mg/g. A strong positive correlation was determined between the altitude of the growth site and the marrubiin content ($\rho = 0.802$, $p = 0.030$, 95% CI [0.094; 0.971]). This indicates that more marrubiin is accumulated at higher altitudes. A very strong negative correlation was also determined between the average annual temperature and the marrubiin content ($\rho = -0.964$, $p < 0.001$, 95% CI [-0.995; -0.759]), indicating that high temperature (e.g., the record heat of 2024) inhibits marrubiin biosynthesis. The studied factors had no statistically significant influence on the phenolic content ($p > 0.05$).

Conclusion: It was determined that all common horehound herb samples from the studied years and locations complies with the European Pharmacopoeia quality requirements of > 0.7% marrubiin, and the accumulation of marrubiin in the raw material is significantly influenced by geographical factors: a strong positive correlation was determined with the altitude of the growth site ($\rho = 0.802$, $p = 0.030$) and a very strong negative correlation with the average annual temperature ($\rho = -0.964$, $p < 0.001$), whereas these environmental conditions had no statistically significant influence on the content of phenolic compounds ($p > 0.05$).

PREFORMULATION OF NAPROXENE-POLYMER-SYSTEM IN AMORPHOUS SOLID DISPERSION

RUSLANS KAČANOVS, VALENTYN MOHYLYUK, ROMAN VITER, KATARĪNA GURKINA,
AGRIS BERZIŅŽ, ZOLTAN MARK HORVATH
ruslans.kacanovs@lu.lv

Institute of Atomic Physics and Spectroscopy, University of Latvia
Address: Jelgavas iela 3, Riga, Latvia LV-1004

Introduction: Naproxen is a nonsteroidal anti-inflammatory drug (NSAID) widely used for the treatment of pain and inflammatory and is generally classified as a Biopharmaceutics Classification System (BCS) Class II compound at most clinically relevant doses, characterized by low aqueous solubility in low pH media and high permeability. The limited solubility of naproxen under physiological gastrointestinal conditions results in a slow dissolution rate, which may negatively affect its oral bioavailability. Amorphous solid dispersions (ASD) have been widely used to enhance the oral bioavailability of such poorly soluble drugs in drug–polymer–solvent system. ASD application of a combined pre-formulation approach represents an effective strategy for optimizing naproxen-polymer-solvent systems efficient manufacturing with enchanted solubility, safety, recrystallization inhibition, physical and chemical stability for naproxen drug formulation.

Methods: Precipitation study was performed in 0.1 N HCl solution with pre-dissolved polymer (60, 40, and 20 wt. %). Naproxen solution in acetonitrile (20 mg/mL) to achieve the proportion of 500 mg of naproxen per 1 L of dissolution medium (0.5 mg/mL) was added. UV absorption was determined directly within 10 mm pathlength quartz cuvettes (at room temperature) with UV-1900i spectrophotometer (Shimadzu, Japan). Spectra were recorded at 5-minute intervals over a 2-hour period.

Film-upon-evaporation with solution forms thin film as solvent evaporates.

FTIR-ATR study of the samples was performed on a FTIR spectrometer (Nicolete IS20, Thermo Scientific, Karlsruhe, Germany) using a diamond prism by scanning from 4000 to 400 cm−1, with 2.0 cm−1 resolution and 100 scans per spectrum.

Results: The precipitation test of Naproxen with polymers (Soluplus, PVAI SRP, PVAI 4-88, and PVAI 3-82) demonstrated that only Soluplus provided favorable results. Therefore, it was selected for film formation using more suitable solvents, namely ethyl acetate and chloroform. FTIR analysis of the films indicated that ethyl acetate may participate in chemical interactions with the components, whereas chloroform showed better compatibility, supporting the formation of a stable amorphous solid dispersion.

Conclusion: A list of solvent-drug-polymer systems for naproxen was successfully narrowed down, with the one among the promising polymer–solvent-drug combination for naproxen amorphous solid dispersion manufacturing being polymer Soluplus in combination with solvents ethyl acetate or chloroform.

SHARING AND BORROWING OF PRESCRIPTION MEDICINES FOR MEDICATION PURPOSES IN ESTONIA

KRISTIINA SUMNIKOVA, DAISY VOLMER
kristiina.sumnikova@gmail.com

Institute of Pharmacy, University of Tartu
Address: Nooruse 1, 50411 Tartu, Estonia

Introduction: Sharing and borrowing of prescription medicines is a common practice in many countries and is often motivated by the intention to help others. However, such behaviour may pose significant health risks, including incorrect dosing, use of inappropriate medicines, and adverse drug reactions. In Estonia, this phenomenon has not previously been studied in depth.

Methods: A quantitative questionnaire-based survey was conducted as part of an international study in 14 community pharmacies across Estonia between January and May 2025. The study included 385 respondents aged 18 years or older with prior experience of using prescription medicines. A translated and culturally adapted international questionnaire was used. Data analysis consisted of descriptive statistics, and associations were assessed using Pearson's chi-square test ($p < 0.05$).

Results: Overall, 26% of respondents reported sharing prescription medicines, and 18% reported borrowing them. These behaviours occurred relatively infrequently and were more common among younger and middle-aged adults and those with higher education. The most commonly shared and borrowed medicines were analgesics and allergy medicines, followed by sedatives, hypnotics, and antidepressants. Medicines for cardiovascular diseases, diabetes, and antibiotics were shared or borrowed less often.

Conclusion: Sharing and borrowing of prescription medicines in Estonia is relatively uncommon but constitutes a potentially health-threatening behaviour. The main reasons included acute or unexpected needs for treatment, absence of necessary medicines at home, and trust between close contacts. The findings highlight the need to increase public awareness of the risks associated with sharing and borrowing prescription medicines and to support preventive measures and educational campaigns to promote safer medicine use in Estonia.

MEDICATION AND DIETARY SUPPLEMENT USE IN ELDERLY POLYPHARMACY PATIENTS IN OUTPATIENT CARE IN ESTONIA

MARGIT VALGE, DAISY VOLMER
margit.valge@ut.ee

Institute of Pharmacy, University of Tartu
Address: Nooruse 1, 50411 Tartu, Estonia

Introduction: Polypharmacy is common among elderly patients and increases the risk of adverse effects, drug-drug interactions, and inappropriate medication use in outpatient care. The aim of the thesis was to describe the use of medications, dietary supplement, and herbal product among Estonian outpatients aged 65+ with polypharmacy, and to identify problems associated with their treatment regimens.

Methods: A prospective observational study was conducted with 21 patients with polypharmacy (≥5 prescription medicines and over-the-counter medicines, if applicable also dietary supplements and/or herbal preparations) at 21 pharmacies across Estonia. Data were collected using the "brown bag" method, structured interviews, adherence and lifestyle questionnaires, and medication lists that combined e-prescription records with actual reported use. Identified issues were categorized as medication-induced, patient-related, regimen/form-related, or prescriber-related problems.

Results: A total of 103 polypharmacy-related problems were identified in the treatment regimens of 21 patients including 79 medication-related and 24 supplement-related issues. Of these, 60% could have been resolved through pharmacist counselling. At least one medication-related problem was identified in 20 of the 21 patients. The most frequent issues were patient-related errors (e.g., incorrect timing, irregular use; 24 cases) and medication-induced adverse effects/interactions (27 cases). Opportunities for simplification of treatment regimens, duplicate medications, and unnecessary preparations were found in seven cases, while prescriber-related dose or duration problems occurred in nine cases.

Conclusion: Treatment regimens of elderly Estonian polypharmacy outpatients commonly contain multiple medication-related problems, particularly administration errors, adverse effects, and interactions. Systematic medication reviews conducted in pharmacies using "brown bag" method and structured assessment tools provide a practical approach for identifying and optimizing these regimens.