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Original scientific paper

Development of an extemporaneous veterinary oral paste formulation with praziquantel and ivermectin for equine

Mladena Lalić-Popović[1,2], Nemanja Todorović[1], Ivana Čabarkapa[3], Miroslav Hadnađev[3], Tijana Kukurić[4] and Zorana Kovačević[4*]

[1]Department of Pharmacy, Faculty of Medicine, University of Novi Sad, Novi Sad, Serbia
[2]Centre for Medical and Pharmaceutical Investigations and Quality Control, Faculty of Medicine, University of Novi Sad, Novi Sad, Serbia
[3]Institute of Food Technology, University of Novi Sad, Novi Sad, Serbia
[4]Department of Veterinary Medicine, Faculty of Agriculture, University of Novi Sad, Novi Sad, Serbia

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ABSTRACT

The development of oral paste for horses through drug compounding represents a significant advancement in the veterinary medicine. In many countries limited availability of commercial anthelmintic medications has posed challenges. To address this issue, a compounded oral paste containing a combination of praziquantel and ivermectin has been developed. On the basis of authorized veterinary medicine products and a risk assessment, three different lipophilic bases for placebo oral pastes were selected: two contained mixtures of natural triglycerides and one had synthetic ones (shea butter, cacao butter and hard fats). Additionally, pharmaceutical formulations consisted of sucrose, hydroxypropyl methylcellulose and glycerol. The pharmaceutical-technological characterization, rheological assessments and microbiological evaluations of the compounded oral pastes were used as selection criteria for creating an optimal formulation. All three placebo formulations were microbiologically stable for 45 days (<10 CFU/g), but the formulation with shea butter had the best spreadability and rheological characteristics. The final formulation consisted of 30% powdered particles with appropriate particle size distribution. The frequency sweep oscillatory rheological measurements (0.1-10 Hz) revealed a domination of storage modulus (G') over loss modulus (G") in all tested pharmaceutical formulations, suggesting solid-like viscoelastic behavior. Although the replacement of sucrose with praziquantel and ivermectin led to a slight decrease in spreadability, it was still superior to the other two placebo formulations. This newly developed extemporaneous preparation with a fixed combination of active pharmaceutical ingredients (praziquantel and ivermectin) offers the single application of two anthelmintic drugs. The compounded drugs ensure the fulfillment of the specific needs regarding accuracy of dosing, optimal therapeutic outcomes, and palatability.

Key words: veterinary compounding; horses; rheology; anthelmintics

* Corresponding author:
Zorana Kovačević, Associate Professor, Department of Veterinary Medicine, Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia, phone: +381 21 4853524, fax: +381 21 453900, e-mail: zorana.kovacevic@polj.edu.rs

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Introduction

Drug compounding represents a vital practice in veterinary medicine, providing customized medications tailored to the specific needs of individ- ual animals (FORSYTHE and GOCHENAUER, 2023). Furthermore, to expand the available dosage forms, reduce costs and address issues related to the availability of active pharmaceutical ingredi- ents (APIs), many veterinarians rely on compound- ing (HUNTER and MADIGAN, 2023). Moreo- ver, the popularity of veterinary compounding is highlighted by the involvement of the American Animal Hospital Association (AAHA), which has endorsed veterinary pharmacy as a preferred supplier for veterinary hospitals (KIRK, 2022). This endorsement aims to provide veterinarians with guidelines for compounding practices (HUNTER and MADIGAN, 2023). So far, the development of compounded drugs has been more present in small animal practices, but while novel dosage forms are convenient for pet owners and veterinary staff, their demonstrated efficacy and safety remain unproven and a concern (HUNTER and MADIGAN, 2023). Besides, there are very few published studies in which drugs for veterinary patients have been tested for stability under the conditions used during compounding (PAPICH, 2005). Actually, this personalized approach ensures that animals receive the most appropriate and effective treatments, enhancing their health and wellbeing, since the lack of commercially available drug formulations often leads the veterinarian to prescribe or dispense a product specifically designed and compounded for their patients' medical needs (BOOTHE, 2006).

Parasite infections represent a significant health problem in animals and cause significant economic losses in animals, especially in horses (BONSI et al., 2023; TORGERSON and MACPHERSON, 2011). There are many factors that influence the occurrence, maintenance and spread of parasitosis, including: keeping of animals of different species together, different age categories of animals, favorable climatic conditions for the development and survival of paraparasitic stages, and transitional hosts, which are necessary for the development of certain types of parasites in the external environment, and therefore the infection of animals. The absence or inadequate implementation of control measures also contributes to the occurrence of parasitosis (PAVLOVIĆ et al., 2023). Unlike in other European countries, there is a high prevalence of various parasitosis in horses in the Republic of Serbia (PAVLOVIĆ et al., 2023; ILIĆ et al., 2023). Twelve thousand horses were registered in the Republic of Serbia in the last record- ed year - 2022, while there were 15,000 in 2015 (STATISTICAL OFFICE OF THE REPUBLIC OF SERBIA, 2024). Although according to this data, the number of horses in the Republic of Serbia is decreasing year by year, there is a great need for treatment of helminthiasis in horses, precisely because of the prevalence of this disease. For these reasons, pharmaceutical companies do not have sufficiently large economic profitability to develop and license drugs for the treatment of any diseases in the horses, including parasite infections. A paste with a fixed combination of praziquantel and ivermectin is indicated for the treatment of equine parasitosis because of the broad-spectrum activity of the combination, and there are licensed veterinary medicinal products (VMPs) with combination of this antiparasitic APIs (VMD, 2018; HPRA, 2019; DEFRA, 2020). However, this fixed combination in not licensed for use in the Republic of Serbia. Despite the effectiveness of these drugs, the limited availability of commercial formulations combining both praziquantel and ivermectin poses a challenge for equine veterinarians, particularly in regions where access to VMPs is restricted.

When it comes to the treatment of any dis- eases in animals, veterinary medicinal products (VMPs) must be administered in accordance with the prescribing cascade (EMA, 2023). This is also in accordance with Law on Medicine and Med- icine Devices in the Republic of Serbia (LAW ON MEDICINES AND MEDICAL DEVICES REPUBLIC OF SERBIA, 2017). So, to address this gap, there is a need for an extemporaneous oral paste formulation that combines these two APIs (praziquantel and ivermectin), ensuring both convenience and compliance in its administration. Furthermore, unlike mass-produced pharmaceuticals, compounded drugs offer flexibility in their formulation, dosage, and administration routes

(FORSYTHE and GOCHENAUER, 2023), which is particularly important for species with unique therapeutic requirements, such as horses. Palatability, ease of administration, and dispensing factors are among the considerations to be taken into account when formulating drugs for an- imals (PAPICH, 2005).

Hence, this paper aims to report the development of a custom-made simple formulation of an oral paste for horses containing antiparasitic API (ivermectin and praziquantel). The pharmaceutical-technological characterization, the rheological assessments and the microbiological evaluation were performed on three placebo formulations (paste basis). The oral paste basis contained lipid components (shea butter, cocoa butter and Witepsol H15), a viscosity-increasing agent (hydroxypropyl methylcellulose, HPMC) and a levigation agent (glycerol). Following the test results, the most suitable base was selected to incorporate APIs, and all these tests were performed on the oral paste.

Materials and methods

Material. Ivermectin and praziquantel were purchased from the North China Pharmaceutical Group Aino Co (China). The following excipients were used in the study: Hydroxypropylmethylcellulose, HPMC (Sigma Aldrich, USA), sucrose (SB Trade, Serbia), glycerol (Lachner, Czech Republic), shea butter (Avenalab, Serbia), cocoa butter (Avenalab, Serbia) and Witepsol H15 (Oleochemicals, Germany). Natural (shea butter, cocoa butter) and synthetic (Witepsol H15) triglycerides were chosen for the experiments, based on the authorized veterinary formulations with s fixed combination of ivermectin and praziquantel in the European Union which contain hydrogenated castor oil.

Composition and compounding of formulations. Pastes containing 30% of the powders were formulated. Placebo pastes F1, F2 and F3 (APIs replaced by sucrose) were formulated for the initial tests. Formulation F4 contained the APIs and the base with the most suitable results from the preliminary tests. The composition of all four formulations is given in Table 1.

In accordance with the regulations for pharmacy practice in the Republic of Serbia, 10 pastes were compounded at the same time. The powder components (ivermectin, praziquantel, HPMC and sucrose) were weighed on a technical balance (Denver Instrument, USA). The powders were transferred to an appropriately sized container (about half of the volume was empty) to ensure proper mixing. A powder mixer (Farmalabor, Italy) was used for mixing at a speed of 130 rpm (intensity 5/5) for 10 minutes. Furthermore, glycerol was added to the mixed powder, and mixing was continued with a pestle in an enameled apothecary bowl. The fatty component of the base (shea butter, cocoa butter or Witepsol H15) was melted in a water bath (Memmert, Germany) and added to the mixture of glycerol and powders. After complete cooling, the compounded pastes were packed in 10 mL syringes. In order to ensure the delivery of AFS to animals in the appropriate dose, the retention of

Table 1. Composition of tested formulations

INGREDIENTS	FORMULATIONS (7.5 g)			
	F1	F2	F3	F4
ivermectin	/	/	/	0.1
praziquantel	/	/	/	0.75
HPMC	0.3	0.3	0.3	0.3
sucrose	1.95	1.95	1.95	1.1
glycerol	2.63	2.63	2.63	2.63
shea butter	2.63	/	/	2.63
cocoa butter	/	2.63	/	/
Witepsol H15	/	/	2.63	/

the preparation in the applicator was determined experimentally. The obtained results were taken into account during packaging. Gloss was evaluated as the degree of light reflection from the surface of the preparation. Shape integrity was assessed as the degree to which the preparation retained its shape when standing, and stickiness as the difficulty of separating the index finger from the thumb when the preparation was placed between them. Scores were given from 1 (the least pronounced observed characteristic) to 10 (the most pronounced observed characteristic).

Risk assessment. The risk assessment for compounding the oral paste was done according to the recommendations given for human medicines in the Resolution of the Council of Europe CM/Res(2016)1 (COUNCIL OF EUROPE, 2016), by a health specialist in the pharmaceutical technology. Five risk factors were evaluated: the type of preparation, the amount prepared annually (units), the pharmacological effect of the active substances, the preparation process and supply. By multiplying the scores of the individual risk factors, the total risk factor was obtained. For values higher than 100, extemporaneous compounding is not recommended, i.e. the medicines must be produced in accordance with the guidelines of Good Manufacturing Practice. For values less than or equal to 100, it is possible to apply the Good Pharmacy Practice guidelines for compounding of medicines.

Appearance. Ph. Eur. 11 prescribes examination of the appearance of extemporaneous preparations, when the implementation of standard tests is not possible (e.g. batch size, time restraints) (EUROPEAN PHARMACOPOEIA, 2022). Color, gloss, shape integrity and stickiness were determined by visual observation of the preparation.

Sieve test. Twenty-five grams of a powder sample were weighed and transferred to a vibratory sieve shaker (Retsch, Germany). The masses of the sieve, 355, 140, and the receiving vessel were measured before and after sieving. The end point of sieving was determined when, after additional sieving, the mass change on a single sieve was less than 5%. The particle size distribution was shown in a histogram.

Spreadability. The spreadability was tested immediately after compounding by using an extensometer, at room temperature. The extensiometer consists of two glass plate. The lower plate is the holder of the sample, and weights of known mass are placed on the upper plate. The test was done with 0.5 g of each sample, and using 50, 100, 200, 300 and 500 g weights. One minute after weight placement, the diameter of the preparation was measured and the surface calculated according to Equation 1. All measurements were made in triplicate.

$$P = \left(\frac{D}{2}\right)^2 \times \pi \quad /1/$$

where are P - the surface in cm^2 of the spread preparation and D - the diameter in cm of the spread preparation.

Rheology. A Haake MARS rheometer (Thermo Scientific, Karlsruhe, Germany) equipped with PP35 S serrated measuring geometry and a gap of 1 mm was used for rheological characterization. The results were interpreted by HAAKE RheoWin Data Manager software (version 4.80.001). Dynamic oscillatory measurements (frequency sweep measurements and stress sweep measurements) were conducted for all samples. Frequency sweep tests were carried out in triplicate in a previously determined linear viscoelastic region, in the frequency range of 0.1–10 Hz, at a constant stress of 1 Pa. All measurements were performed at 25°C.

Microbiological quality. The counting and determination of aerobic mesophilic bacteria was carried out in accordance with EN ISO 21149:2017. Non-selective agar was used as a medium in order to determine the colonies. Ten g of the sample was used, dispersed in 90 ml of sterile Eugon broth. The dispersion was incubated at 32.5°C±2.5°C for at least 20 hours. After this, a tenfold dilution was arranged using a 0.1% peptone solution (10^{-1} to 10^{-7}). Each dilution was seeded in petri plates with a non-selective agar medium (Tryptone Soy Agar). The petri plates were incubated at 32±2.5°C for at least 72 hours. The results were presented as the number of colonies formed per gram of sample (CFU/g).

Results

A risk assessment for the compounding of a fixed combination of APIs (ivermectin and praziquantel) in the form of an oral paste was carried out by a pharmaceutical technology health specialist. According to the obtained results, the overall risk, based on individual risk factors, could be assessed as low and the oral paste compounded in accordance with Good Pharmacy Practice Guidelines. The quantification of the risk assessment is present- ed in Table 2.

Formulation F3, which contained solid fats (Witepsol H15) as a base, was intensely white in color and had the highest degree of gloss of all the formulations observed. Formulation F2, with shea butter, was yellow and without gloss. Replacement of sucrose from the placebo formulation F1 with APIs in the formulation F4 led to an increase in the intensity of the white color and a slight increase of gloss. The integrity of the shape increased slightly with the addition of APIs, and the stickiness decreased. The evaluation of the physical appearance of the obtained formulations is shown in Table 3, and a photograph of the placebo formulations in Fig. 1.

The particle size distribution test of sucrose showed that the fraction of particles with a size between 140 and 355 μm was the most dominant with a share of 46.99±5.49%. Particles smaller than 140 μm had a share of 39.25±9.19%, and those larger

Table 2. Risk assessment of the oral paste compound

Formulation	Type of preparation	Amount prepared annually (units)	Pharmacological effect of the active substances	Preparation process	Supply	Total
F4	3	1	3	2	1	18

Table 3. Physical appearance of the obtained formulations

Formulation	Color	Gloss	Integrity of the shape	Stickiness
F1	white (1)	1	7	5
F2	yellowish	1	10	3
F3	white (10)	3	9	2
F4	white (5)	2	8	4

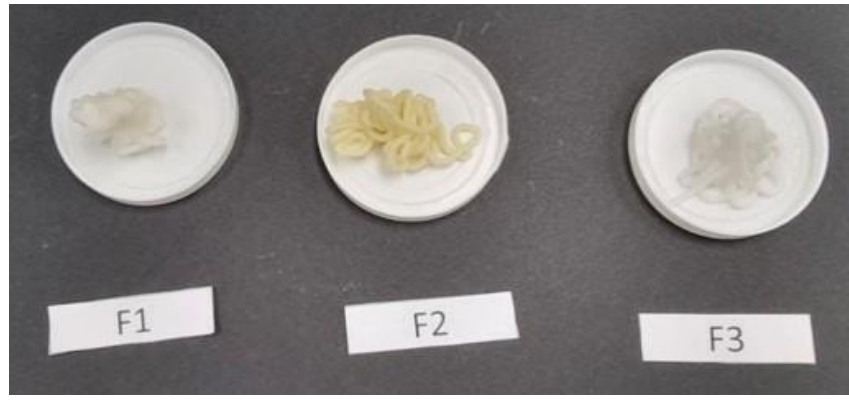

Fig. 1. Photographs of the compounded placebo formulations

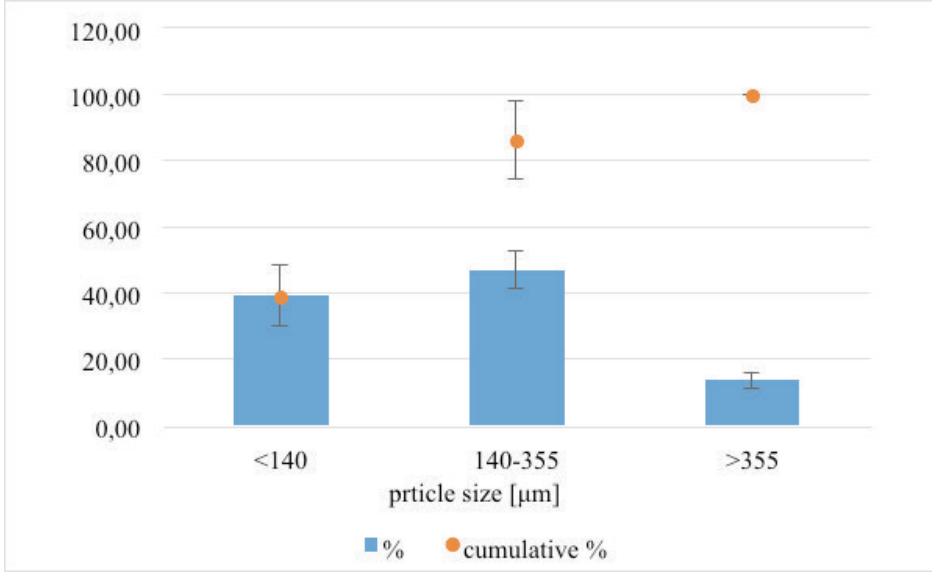

Fig. 2. Particle size distribution

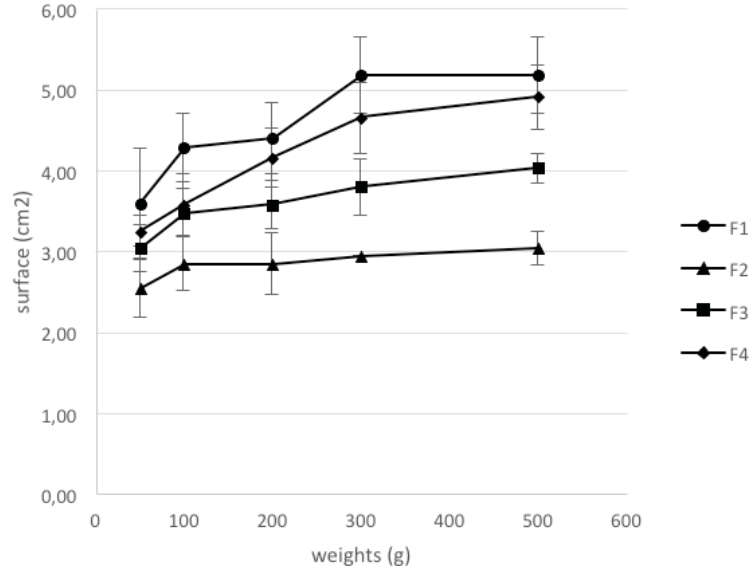

Fig. 3. Spreadability of tested formulations

than 355 µm had a share of 13.76±2.25%. The size distribution of sucrose particles is shown in Fig. 2.

The spreadability of the tested formulations F1, F2, F3 and F4 is presented in Fig. 3. First, formulations F1 and F4 (with shea butter as a fatty component of the base) showed the highest spreadability, under the influence of the smallest mass weight (50 g). Furthermore, the most significant change in the surface after increasing the weights was also observed in the same formulations, F1 and F4. Both the initial surface and its change suggest that formulations F1 and F4 have the best spreadability. Interestingly, formulation F3 (with Witepsol H15) showed better spreadability than formulation F2 (with cacao butter), but both had worse spreadability than formulations with shea butter.

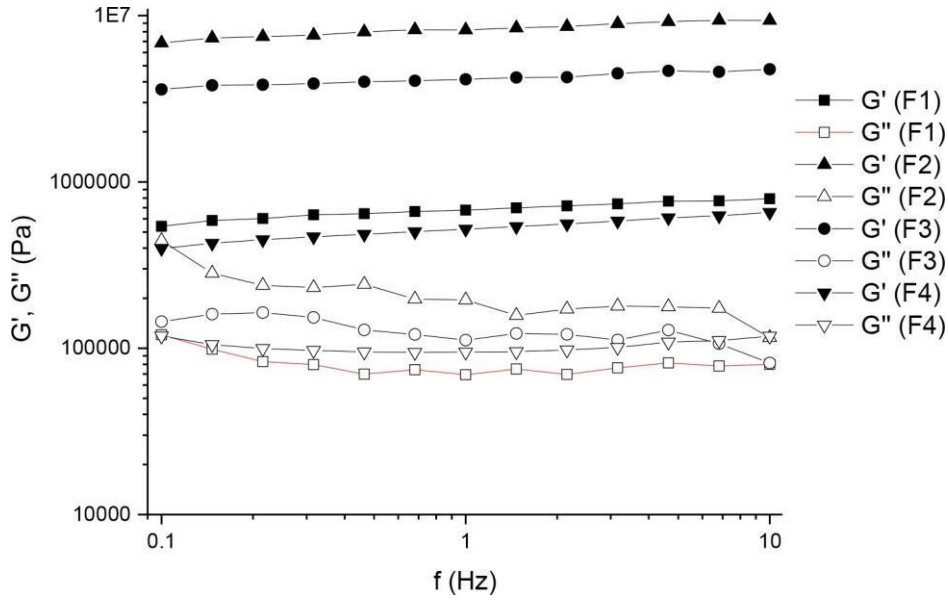

Fig. 4. Results of frequency sweep measurements

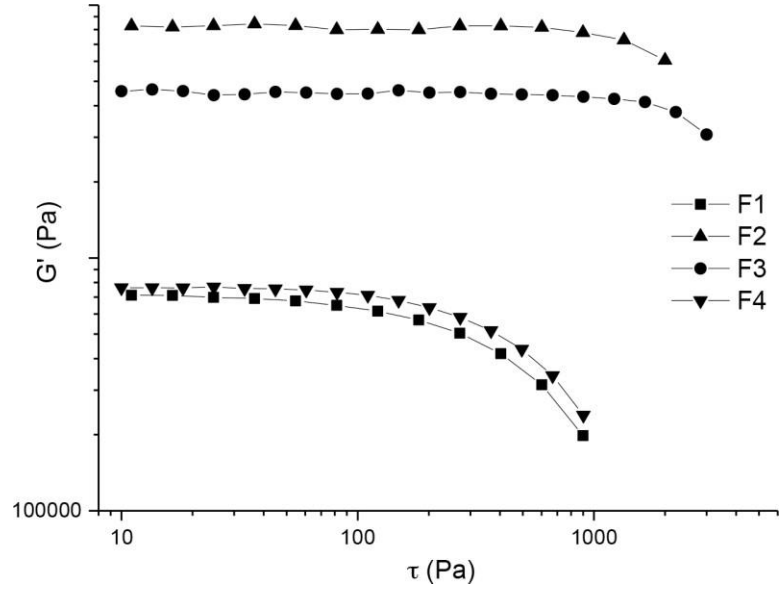

Fig. 5. Results of stress sweep measurements

The results of rheology testing are presented in Fig. 4 and 5. Elastic modulus (G') dominates over viscous modulus (G") in the entire frequency range observed in all four tested formulations, indicating solid-like viscoelastic behavior. Formulation F2 (with cocoa butter) has the most pronounced elastic properties and the strongest gel structure, followed by formulation F3 (with Witepsol H15), F4 and F1 (with shea butter). Formulations F4 and F1 had similar rheological behavior since the same fat (shea butter) was used which strongly influenced its viscoelastic behavior. However, considering G"

Table 4. Results of microbiological testing

Formulation	0 day	15 day	30 day	45 day	Method used
	Mesophilic aerobic bacteria				EN ISO 21149:2017
F1	<10 CFU/g	<10 CFU/g	<10 CFU/g	<10 CFU/g	
F2	<10 CFU/g	<10 CFU/g	<10 CFU/g	<10 CFU/g	
F3	<10 CFU/g	<10 CFU/g	<10 CFU/g	<10 CFU/g	

to G' ratios (tan δ) and the values obtained by the stress sweep tests, it can be concluded that formulation F4 showed a slightly stronger gel structure than formulation F1, which can be also seen from the length of the viscoelastic range (Fig 5).

The results of the microbiological quality test showed that the selection of the fatty component of the paste base did not affect the microbiological quality during the tested period of time. All tested formulations had <10 CFU/g mesophilic aerobic bacteria after 45 day from the beginning of the test. The results are presented in Table 4.

Discussion

The compounding method described in this paper provides comprehensive insight into the development of the compounded oral paste formulation for horses, starting with paste base selection based on safety, spreadability and rheological properties. Ivermectine and praziquantel were chosen as APIs, as mentioned earlier, since there is no authorized combination with these antiparasitic drugs on the Serbian market. Thus, compounding the oral paste is justified. All considered paste bases were lipophilic, and the formulation of the investigated paste bases was developed using formulations authorized elsewhere that are in the same pharmaceutical form (oral paste for horses). Additional justification for oral paste compounding lies in the fact that a previous study (REHBEIN et al., 2003) proved that the combination of ivermectin and praziquantel in an oral paste is highly effective in reducing egg shedding by gastrointestinal nematodes and cestodes, and claimed that no adverse reactions were observed in horses treated under field conditions. Furthermore, the risk assessment for the compound formulation developed in this study showed a low risk. However, during the risk assessment we were guided by the resolution provided for human medicines due to the absence of one for veterinary medicines. In the future, we should base our research on developing risk assessment guidelines for compounding veterinary medicines that would incorporate specific risk factors, such as whether the compounded medicine is for food producing animals or for non-food producing ones.

Previously published studies have shown the significant influence of composition on the pharmaceutical technological characteristics of veterinary compounded formulations (KOVAČEVIĆ et al., 2023). Selection of the paste base was based on lipid component, sweetener, viscosity enhancer and levigation agent. As the lipid component two natural bases, shea butter and cocoa butter, were selected. Also, the usual substitute for cocoa butter in magistral practice, Witepsol H15, was used. Glycerol was used as the common levigation agent, since it is sweeter than propylenglycole, which is also common in oral authorized paste formulations. Likewise, the viscosity of the paste was adjusted by using HPMC. HPMC was selected due to the fact that it is commonly used in pharmaceutical compounding, and also has mucoadhesive properties which might favor APIs bioavailability (SCHWARZ et al., 1994; ILLAN et al., 1996).

Praziquantel is a small molecule that is a derivate of isoquinolone, with melting point at 142°C. It is highly lipophilic and sparingly soluble in water (pH 1-7.5) (PERSSON et al., 2013). It belongs to BSC class II. Praziquantel is known to have structural and crystal polymorphism. Polymorph B may be present in a mixture after milling polymorph A (D'ABBRUNZO et al., 2024). Additionally, praziquantel has two enantiomers and it is known that schistosomicidal activity relies on the (R)-enantiomer, while the (S)-enantiomer is

mainly responsible for the bitter taste and side effects (D'ABBRUNZO et al., 2024). Ivermectin is a macrocyclic lactone derivative. It is a liposolu- ble molecule, with low water solubility (about 4 mg/ml) and melting point, at 155˚C (BLOOM and MATHESON, 1993). It also belongs to BSC class II. Its solubility in simulated intestinal fluid with (FaSSIF) is 0.12 mg/ml and without bile salts (SIF) 0.0007 mg/ml (TAKANO et al., 2006). Thus, the selected compounding technique is not expected to alter the physicochemical properties or affect the stability of praziquantel and ivermectin.

Pharmaceutical grade ivermectin powder is irregular in shape, with particle size 44-200 µm (STARKLOFF et al., 2017). Pharmaceutical grade praziquantel powder has particles that are needle (polymorph A) and block like shapes (polymorph B), or irregular if it is in an amorphous state. Particle size distribution is commonly around 75 µm (TRASTULLO et al., 2015). In our study, sucrose was used in the placebo formulation to maintain powder mass, however, we determined that its particle size distribution ranged between 140 and 355 µm (Fig. 2). This led to the poorer spreadability of the F4 formulation with APIs compared to the placebo F1 formulation. Additionally, the gel structure was stronger in F4 compared to F1 (Fig.4 and 5). Sucrose remained in the final formulation with APIs as a sweetener. Sucrose easily available and economical for compounding. The disaccharide of glucose and fructose is obtained from natural sources such as sugar cane (*Saccharum officinarum* L.) or sugar beet (*Beta vulgaris*) which makes it suitable for horses. Considering horses' preference for a sweet taste, the addition of sucrose in the oral paste formulation potentially contributes to increasing the palatability of the preparation (SHESKEY et al., 2017; ORSYTHE and GOCHENAUER, 2023; SMITH et al., 2024).

Development of an oral paste formulation intended for compounding should be based on the idea that it should be inexpensive for horse owners and ready for use without the need for further component addition or dilution. Also, the oral paste formulation must flow freely through the feed line to the drench gun or applicator, and be dispensed with the minimum of muscular effort by the operator. Thus, paste base selection was performed using the results of spreadability and rheological assessment. In our research HPMC was used as viscosity-increasing agent, but in all placebo formulations (F1, F2 and F3) and the final F4 formulation portion of HPMC was the same (4%). HPMC is widely used in various pharmaceutical formulations, including those for oral administration. Its effect on increasing the viscosity in liquid and topical formulations is known, so HPMC is used as a thickening agent. Hence, its presence in pharmaceutical formulations contributes to stability and prevents the agglomeration of the particles. Furthermore, glycerol is a multifunctional excipient in the oral paste formulation. Glycerol has several important pharmaceutical-technological functions in the preparation: as a levigating and wetting agent, it contributes to increasing powder incorporation, and as a humectant, it prevents drying of the dosage form. Additionally, glycerol is used as a thickening (viscosity-increasing) agent and is suitable for providing physical stability through increased viscosity/thickness. If glycerol is present in the appropriate concentration, it will also have the function of an antimicrobial preservative (SHESKEY et al., 2017; FORSYTHE and GOCHENAUER, 2023). Just like HPMC, glycerol was in concentration of 35.07% in all formulations, thus it did not affect the viscosity the placebo formulations (F1, F2 and F3). Also, sucrose and glycerol resulted in the sweet taste and affected the texture of the formulations. The sweet taste and consistency together may enhance palatability and contribute to the function of palatants, which is of great importance for all veterinary medicines (KOVAČEVIĆ et al., 2020).

The spreadability results correlate with the rheology assessments. It is interesting to mention that differences in spreadability and viscosity are due to the lipid components. Formulation F2 with cocoa butter had the worst spreadability and the strongest gel structure, followed by formulation F3 with Witepsol H15, and finally F1 with shea butter. As a result, F1 was selected as the most suitable for the oral paste base. Good spreadability is important for appropriate packing and administration, as well as adequate spreading of medicines at the site of action. Addition of APIs (formulation F4) led to a

slight decrease in spreadability and elastic properties, probably due to the smaller particle size distribution of the powder particles.

There was more than 30% of glycerol in the investigated formulations, which is enough to have a preservative effect. This was proved by microbiology tests that showed all three paste vehicles were stable for the 45 days of testing (Table 4).

The liposoluble paste base used in this research is justified since both APIs are highly liposoluble, thus ensuring that APIs target the site of infection. It was previously proven that for the benzimidazole and ivermectin and similar chemical classes of compounds, efficacy is dependent upon the presence of concentrations that are 'toxic' in the target parasite and also the duration of such APIs concentrations (LACEY, 1988; HENNESSY, 1997). In order to avoid subtherapeutic activity, a liposoluble base in combination with liposoluble APIs is suitable.

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Declaration of competing interest

The authors declare no conflict of interest.

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LALIĆ-POPOVIĆ, M., N. TODOROVIĆ, I. ČABARKAPA, M. HADNAĐEV, T. KUKURIĆ, Z. KOVAČEVIĆ: Razvoj magistralnog pripravka oralne paste za konje na osnovi kombinacije prazikvantela i ivermektina. Vet. arhiv 95, 251-262, 2025.

SAŽETAK

Razvoj magistralne oralne paste za konje predstavlja značajan napredak u veterinarskoj medicini. U mnogim zemljama ograničena dostupnost komercijalnih antihelmintskih lijekova predstavlja izazov. Kako bi se riješio ovaj problem, razvijena je magistralna oralna pasta koja sadrži kombinaciju prazikvantela i ivermektina. Na temelju odobrenih veterinarskih lijekova i procjene rizika odabrane su tri različite lipofilne podloge za placebo oralne paste: dvije sadrže mješavine prirodnih triglicerida a jedna sintetskih triglicerida (shea maslac, kakao maslac i tvrde masti). Osim toga, farmaceutske formulacije sadržavale su saharozu, hidroksipropil metilcelulozu i glicerol. Farmaceutsko-tehnološka karakterizacija, reološke ocjene i mikrobiološke ocjene magistralnih oralnih pasti korištene su kao kriterij odabira za izradu optimalne formulacije. Sve tri placebo formulacije bile su mikrobiološki stabilne tijekom 45 dana (<10 CFU/g), ali formulacija sa shea maslacem ima najbolju razmazivost i reološka svojstva. Konačna formulacija sastojala se od 30% praškastih čestica s odgovarajućom raspodjelom njihove veličine. Frekventno ovisna oscilatorna reološka mjerenja (0,1-10 Hz) ukazuju na dominaciju modula pohrane (G') nad modulom gubitka (G") u svim testiranim farmaceutskim formulacijama što ukazuje na čvrstoću sličnu viskozno elastičnim osobinama. Iako je zamjena saharoze prazikvantelom i ivermektinom vodila do blagog smanjenja razmazivosti, još uvijek je finalna formulacija bila bolja nego u druge dvije placebo formulacije. Ovaj novorazvijeni magistralni pripravak sa fiksnom kombinacijom aktivnih farmaceutskih sastojaka (prazikvantel i ivermektin) omogućava jednokratnu primjenu dvaju antihelmintika. Magistralni pripravci osiguravaju ispunjavanje specifičnih potreba u pogledu točnosti doziranja, optimalnih terapijskih ishoda i palatabilnosti.

Ključne riječi: magistralni pripravak; konji; reologija; antihelmintici