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Palatability Testing of Spray-Dried Animal Plasma-Infused Dog Foods and Treats

Katarzyna Kazimierska [1,*], Wioletta Biel [1] and Robert Iwański [2]

[1] Department of Monogastric Animal Sciences, Division of Animal Nutrition and Food, Faculty of Biotechnology and Animal Husbandry, West Pomeranian University of Technology in Szczecin, 71-270 Szczecin, Poland; wioletta.biel@zut.edu.pl
[2] Department of Fish, Plant and Gastronomy Technology, Faculty of Food Sciences and Fisheries, West Pomeranian University of Technology in Szczecin, Papieża Pawła VI 3, 71-459 Szczecin, Poland; robert.iwanski@zut.edu.pl
* Correspondence: katarzyna.kazimierska@zut.edu.pl

Abstract: The global pet food market is expanding rapidly, and there is a growing interest in sustainable, high-quality ingredients. Spray-dried animal plasma (SDAP), a protein-rich by-product with immune-boosting properties, is gaining attention as a potential additive. This study aimed to evaluate the palatability of dog products containing SDAP. Three types of canine products (dry food, wet food, and treats) with varying concentrations of SDAP (0%, 1%, 2%, and 4%) were tested. The study used a two-bowl preference method involving 20 dogs of different breeds, ages, and weights. Results indicated that a 2% SDAP concentration significantly increased the palatability of each dog food compared to control diets without SDAP, while higher concentrations (4%) negatively impacted it. For dry food and treats, the inclusion of 1% SDAP showed marginal effects on palatability. Statistical analyses revealed no significant correlation between the dogs' sex or product type and their preference for SDAP-containing products ($p > 0.05$). This preliminary research supports the inclusion of SDAP in dog foods, particularly at optimal levels (2%), to enhance palatability and meet the nutritional needs of dogs while addressing sustainability in pet food production.

Keywords: spray-dried porcine plasma; canine diet; dry food; wet food; palatability; two-bowl preference test; pet food; additives; sustainability

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1. Introduction

The global pet food market is a rapidly growing industry, valued at approximately USD 176 billion worldwide in 2023, with an expected compound annual growth rate (CAGR) of 8.5% from 2024 to 2029 [1]. This growth is driven by an increasing pet ownership rate and a rising trend towards premiumization in pet food products, where pet owners are more willing to invest in high-quality, nutritious food for their pets. Notably, the demand for pet food increased significantly in 2020, coinciding with consumers adopting pets for companionship during the COVID-19 lockdowns [2,3]. However, regional sales experienced stagnation in 2022, but rebounded to achieve modest, yet positive, growth by 2023 [4]. As a result, manufacturers are continually seeking innovative ingredients that can enhance the palatability and nutritional value of their products to meet consumer demands.

Currently, the threats of climate change and supply shortages are highlighting the importance of sustainable ingredients in the pet industry. Given the significant size of the pet food market, it has become critically important in recent years to identify alternative, sustainably sourced ingredients for use in the pet food industry [5–8], with particular focus on protein. One such ingredient is spray-dried animal plasma (SDAP), an animal by-product (ABP) that offers an affordable source of animal protein in pet food.

Plasma, the essential liquid portion of blood, serves to suspend blood cells and comprises a varied blend of bioactive components with antimicrobial and immune-boosting properties, thereby enhancing animal growth and immune response [9]. In animal nutrition, it is used in powdered form, processed using spray drying to preserve its functional properties [10]. As facultative carnivores, dogs require animal-derived ingredients to optimally fulfill their species-specific nutritional requirements [11]. Consequently, the incorporation of SDAP into commercial dog food can serve as a suitable and beneficial animal protein source, meeting the increasing demand for ingredients aligned with pets' natural dietary needs [12]. SDAP stands out for its high protein content, estimated at approximately 75% [11,13].

SDAP can be used for several purposes in pet food production. Particularly in wet food formulations characterized by high moisture and fat levels susceptible to particle separation, SDAP serves primarily as an emulsifier and binding agent, commonly referred to as a "binder" [12]. Its role in this context enhances water retention, texture, juiciness, and the overall homogeneity of the final product [14–16], while in dry and extruded pet food, the technological potential of SDAP remains relatively unexplored [17], despite the widespread utilization of emulsifiers and binders to enhance kibble properties. Likewise, the application of SDAP in treats and snacks has not been thoroughly investigated, although it is reasonable to anticipate that it possesses properties comparable to other types of animal products.

In recent years, SDAP has emerged as a promising additive in the formulation of canine diets due to its palatability-enhancing properties and nutritional benefits [18,19]. Palatability, which measures food intake and indicates acceptance or preference over other options [20], plays a critical role in the acceptance and consumption of commercial pet foods by dogs. Unlike humans, dogs consume their daily nutritional requirements from a single food source, making proper palatability assessment essential to ensure that pets consume their entire meal and meet their daily nutritional requirements without rejection [21]. Palatability testing is critical in the manufacture of commercial pet foods, providing a key indicator to evaluate the ingredients used and their palatability to dogs in the finished product. Whether a dog will eat a food containing a particular additive also influences the choice of the owner, who must be convinced that the food tastes good or they will abandon the purchase [20]. In addition, optimal palatability not only increases the nutritional intake of dogs but also contributes to their overall well-being and satisfaction. The most common method used to evaluate palatability in pet food research is the two-bowl test, in which two diets are presented side by side for a set period, and subjects indicate their preference by the first bite they take and the amount of food they consume from each bowl. This method is widely recognized as the most reliable and is extensively used to assess palatability in both cats and dogs [22]. Unlike the one-pan method [23], this technique offers the animal a choice between two different options, which is particularly advantageous when testing novel flavor profiles or product enhancements [20].

The addition of SDAP can contribute to the palatability of dog food products and can serve as a valuable ingredient to enhance the sensory appeal of dog food. However, comprehensive evaluations of the palatability of SDAP in different product formats for dogs, including dry food, wet food, and treats, are limited. A deeper understanding of canine preferences for additives and protein sources may further support the use of ABPs in pet foods and convince consumers of their benefits. The aim of this preliminary study was to evaluate the palatability of different SDAP-containing dog products. Controlled preference trials were used to assess the effect of SDAP inclusion on the acceptance and preference of dry food, wet food, and treats by dogs.

2. Materials and Methods

2.1. Ingredients

The tested material consisted of three laboratory-produced types of canine products—dry food, wet food, and treats—with varying concentrations of SDAP additive (0%—control, 1%, 2%, 4%). SDAP was obtained from a commercial supplier in Spain (APC-Europe SLU, Granollers, Spain). The composition of complete dog foods was developed based on the basic composition of the ingredients (Table 1), determined according to AOAC methods [24]. The nutrient composition of the evaluated dry and wet dog foods was formulated to meet the dietary requirements stipulated for adult dogs, as outlined in the FEDIAF nutritional guidelines [25]. These dog foods were formulated so that the proportion of crude protein (CP) and ether extract (EE) averaged 25.56 g (SD = 0.16) for CP and 6.3 g (SD = 0.09) for EE per 100 g of dry matter (DM).

Table 1. The basic composition (g/100 g) of the ingredients used in the production of the analyzed dog foods and treats.

Item	DM	CP	CF	EE	CA	NFE
Animal ingredients						
minced chicken	25.8	19.8	0	6.8	3.9	1.0
poultry liver	18.9	17.0	0	4.8	1.1	0
poultry meal	92.0	63.0	2.0	8.0	13.0	6.0
SDAP	96.8	75.4	0	1.2	12.6	7.5
Plant ingredients						
spelt flour	90.1	13.9	1.7	2.1	1.4	71.1
buckwheat flour	89.1	11.5	1.8	2.7	1.9	71.0
linseed	95.5	21.2	8.0	38.8	3.5	23.9

DM—dry matter; CP—crude protein; EE—ether extract; CF—crude fiber; CA—crude ash; NFE—nitrogen-free extract (calculated as: NFE (wet basis, %) = 100 − (%moisture + %CP + %EE + %CA + %CF); SDAP—spray-dried animal plasma.

Diets were formulated with animal products, including poultry meal and chicken liver. Spelt flour, buckwheat, and linseed were used as carbohydrate sources. Vitamin and mineral mixes were added into the dry and wet food formulations in amounts that ensure the diets met the FEDIAF nutritional guidelines [25] for a complete food for adult dogs. Most of the raw materials were used for all experiments, ensuring similar ingredient acceptability in all formulas. Detailed compositions and the production process of the tested products, differing solely in SDAP content, are provided in Table 2. The control diets were formulated with 0% SDAP and were otherwise identical to the test diets, which contained 1%, 2%, or 4% SDAP. To ensure comparability, the proportions of the other components in the diets were adjusted as needed to maintain chemical balance at levels equivalent to the control products.

Table 2. Production process and main ingredients of analyzed dog products.

Item	Dry Dog Food	Wet Dog Food	Treats
Production process	extrusion	tyndallization	baking
Animal ingredients	poultry meal	minced chicken, poultry liver, poultry meal	poultry meal
Plant ingredients	whole wheat spelt flour, whole grain buckwheat flour, linseed	linseed	whole wheat spelt flour, linseed
Fat source	salmon–trout–linseed oil	salmon–trout–linseed oil	salmon–trout–linseed oil
Other	spray-dried plasma *, guar gum, mineral–vitamin mixture	spray-dried plasma *, guar gum, mineral–vitamin mixture	spray-dried plasma *, guar gum, mineral–vitamin mixture

* Spray-dried animal plasma not added in control pet product (products with 0% SDAP addition).

2.2. Production of Examined Dog Foods

The dry dog food was produced by extrusion using a single-screw laboratory extruder. The ingredients were mixed by adding reverse-osmosis (RO) water, then passed through a laboratory single-screw extruder (Brabender, Duisburg, Germany) with three heating sections: I—85 °C, II—95 °C, and III—98 °C. The final expansion rate and molding pressure was 15 MPa.

The wet food was produced using a fractional sterilization method designed to eliminate vegetative and spore-forming microorganisms, as well as retard bacteria. The components were mixed with RO water, ensuring thorough integration of ingredients. Prior to use, the glass containers were sterilized to maintain a contaminant-free environment. After the preparation of the feed mixture, the containers were filled with the finished product and poured with poultry broth. The rim of each container was meticulously wiped with 96% ethanol before sealing. The process involved a three-step method conducted over consecutive days, with specific durations for each phase: I—60 min, II—40 min, and III—30 min. A 24 h interval was maintained between each step to ensure thorough microbial inactivation. The airtight containers were divided into three tyndallization temperature treatments using a drying oven (UF75, Memmert, Schwabach, Germany): I—100 °C, II—105 °C, and III—110 °C. Then, they were left to cool at room temperature (18–21 °C) for about 12 h.

Dry ingredients for dog treats were mixed, then wet ingredients were added and mixed. From the final dough, the bone-shaped biscuits (2 sizes, small and large) were made. The molded treats were manually transferred to labeled trays. The dog treats were baked in a drying oven (UE400, Memmert, Schwabach, Germany) at 180 °C for 20 min.

2.3. Dogs Involved in the Experiment

In the study, owner dogs were used and remained under the care of their owners throughout the study period. The dietary tests and all experimental procedures were conducted in accordance with the Directive of the European Parliament and of the Council of 22 September 2010 on the protection of animals used for scientific purposes [26]. Consequently, individual consent was not required for the study due to adherence to production standards and conditions.

A total of 20 dogs participated in the study, consisting of 10 males and 10 females. The dogs used were from various breeds, including German shepherds, Labrador retrievers, beagles, fox terriers, dachshunds, and papillons, as well as crossbred dogs. Animals used for the palatability test were qualified before the study. Dogs were healthy with no predisposing illnesses or behavioral problems. The weight range was between 2.5 and 33 kg, and the age range was between 3 and 7 years old (Table 3). This selected subpopulation was chosen to be representative of the broader canine population.

Table 3. Demographic table of dog panel (n = 20 dogs, 10 females and 10 males).

Item	Mean	SD	Minimum	Maximum	Lower Quartile (25th Percentile)	Upper Quartile (75th Percentile)
Age (years)	5.1	0.9	3.0	7.0	4.25	6.0
Weight (kg)	16.9	9.8	2.5	33	9.05	27.8

SD—standard deviation.

2.4. Preference Test

For each type of pet food, a two-bowl preference study [27–31] (Experiment I, dry food; Experiment II, wet food; Experiment III, treats) was conducted over three consecutive days, with three varying concentrations of SDAP, on dogs of different breeds. For the test, twenty pet dogs and their owners participated in an in-home test of the products. Dogs and owners were selected based on agreed-upon criteria after a pre-study questionnaire. The dogs selected for the study had to be healthy, vaccinated, undergoing antiparasitic prophylaxis, and free of food allergies. Each preference trial was repeated twice, with bowl positions altered to mitigate potential side or position biases, thus extending the total duration of the preference test for each product to six days. The owners participating in the study received clear instructions on how to carry out the test procedures and accurately record the results. The scheme of the preference test is shown in the Supplementary Materials (Table S1).

Each morning, following a 12 h fasting period, equal portions of the canine products under evaluation were simultaneously presented to the animals, and their initial selections were recorded daily. Each bowl contained a pre-weighed portion of the specific food variant being tested. The duration of each trial was 20 min. Trials were conducted using combinations of 0% and 1% SDAP, 0% and 2% SDAP, and 0% and 4% SDAP.

After the dogs' initial selections, a determination was made regarding their preferred food. The dogs' preferences were measured by the number of times each bowl was initially selected. Preference was deemed evident if the ratio exceeded 51% or fell below 49% in the preference test [32,33].

2.5. Statistical Analyses

Palatability first-choice results were submitted to chi-squared tests, and p-values < 0.05 were considered statistically significant. All statistical analyses were performed using the Statistica 13.0 software (TIBCO Software Inc., Palo Alto, CA, USA).

3. Results

The results presented in Figure 1 indicate that the inclusion of SDAP affects dog preferences for canine food products to a certain degree. The most notable increase in preference was observed at a 2% SDAP concentration. Conversely, a decline in product palatability was noted at a 4% SDAP concentration. Among the tested variants, the incorporation of 2% SDAP into the wet food was most favored by the dogs ($p < 0.05$), with 73% of dogs selecting it as their primary choice. In contrast, the wet food containing 4% SDAP was the least favored ($p < 0.05$), with only 30% of the dogs choosing it as their first preference. The addition of 1% SDAP to dry dog food did not influence the product's palatability, as dogs selected both the food with and without SDAP equally. Similarly, the inclusion of 1% SDAP in other products, such as wet food and treats, had only a marginal effect on palatability, resulting in either slight decreases (48% as primary choice) or minor improvements (53% as primary choice), respectively.

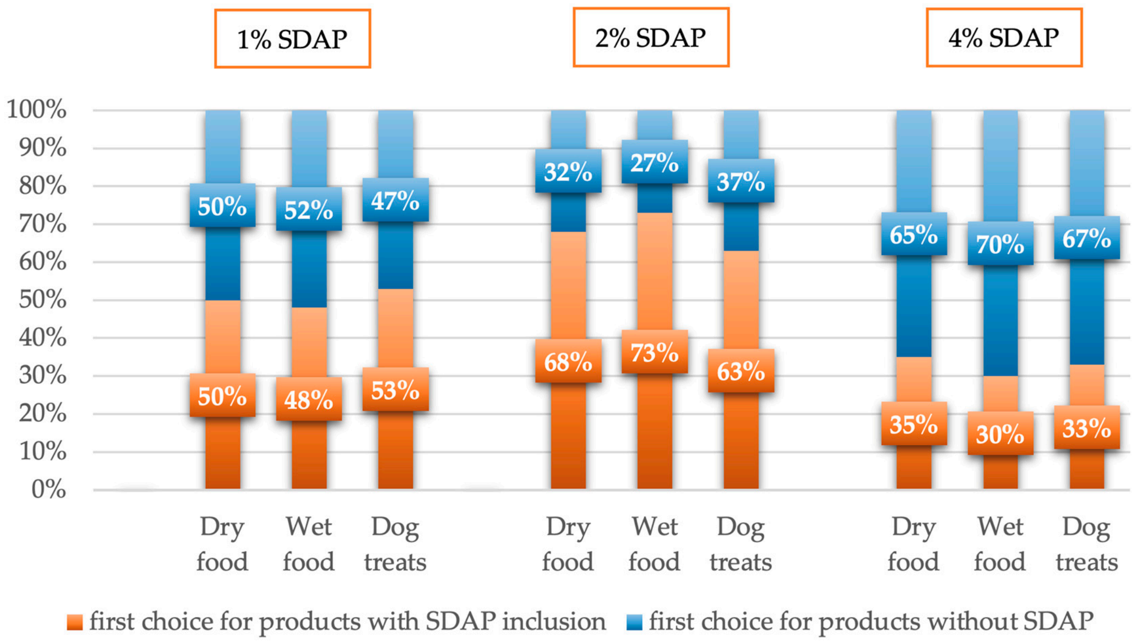

Figure 1. Average preference test ratio of different tested canine products. SDAP—spray-dried animal plasma; The dogs' preferences were measured by the number of times each bowl was initially selected; Results represent the average of the first choices from the two-bowl preference test in 20 dogs.

Statistical analyses did not reveal a significant association between the dogs' first choice of a product with a specific SDAP additive and either the sex of the animals or the type of dog product (in all cases, $p > 0.05$).

4. Discussion

Understanding the intricacies of canine feeding behavior is crucial for devising optimal formulations that enhance palatability while addressing health and welfare considerations. Numerous factors influence a dog's food selection, including the nutritional composition of the food itself. Wet pet food is generally more appealing to pets than dry food due to its enhanced palatability [34], underscoring the pivotal importance of palatability considerations, particularly in the production of dry pet food. Quality control and product development tests for pet foods often involve palatability testing with dogs and cats, underscoring the significance of palatability in pet food formulation [20]. Dry pet foods are the most popular pet food category purchased by pet owners because of their long shelf life, ease of preparation, and low price; however, they tend to be low in terms of their palatability to dogs compared to the wet and semi-moist types [35].

The incorporation of SDAP into dog and cat food formulas is not a novel concept. Due to the documented beneficial effects of this dietary supplement on the growth, immunity, and hematological parameters of livestock [36–46], its use was extended to pets several decades ago. However, the palatability outcomes have not yet been conclusively determined. While in the case of cats, the SDAP additive demonstrated an evident positive impact on food palatability [14,19,47], in the case of dogs, the results were inconsistent.

Polo et al. [14] found that the palatability or first-choice results with dogs were similar in both trials (1. containing 20 g/kg of SDAP or wheat gluten; 2. containing 10 g/kg of SDAP or 30 g/kg of wheat gluten), indicating that dogs cannot differentiate between the two products. Quigley et al. [48] did not find any differences in food intake when dogs were fed diets containing up to 3% SDAP either. Andrade et al. [18] observed that while most dogs showed a preference for a diet without SDAP addition over a diet containing 4% SDAP when both options were presented simultaneously, there was no significant difference in food intake when each diet was offered separately in a digestibility trial. This suggests that dogs do not reject foods (even with up to 12% SDAP), although they may opt for diets without SDAP when given a choice. In contrast, in our study, dogs were more likely to choose products with 2% SDAP content compared to control diets (i.e., 0% SDAP), while they were less likely to choose those with higher SDAP content (4%) (Figure 1). Considering our results alongside those of previous studies, it can be concluded that dogs' preference for SDAP is closely linked to its concentration in the product. Even small differences in the amount of SDAP in the food formulation (1%, 2%, 3%, or 4%) can significantly affect the product's palatability. Based on the results of previous studies and our findings, the addition of SDAP to dog food should be kept at 2%. Higher amounts (even 4%) have been found to reduce the palatability of dog products. It is important to note that a strong initial choice is often correlated with a higher food intake [49–51]. Although food intake was not measured in our study, it is reasonable to assume that the dogs ate more of their first choice.

This study represents the first investigation to specifically examine the impact of SDAP on the palatability of dog treats. While previous research has explored the effects of SDAP in dog food, our study uniquely analyzes its inclusion in treats, which are a significant aspect of canine diets used for training, rewarding, and supplemental nutrition. Our findings demonstrate that a 2% addition of SDAP to dog treats enhances their palatability compared to the control diet (0% SDAP) (Figure 1), making them more appealing to dogs. This enhanced palatability can be particularly beneficial for products aimed at training or therapeutic purposes, where high acceptance is crucial.

5. Conclusions

Based on the preliminary results of this study, it can be concluded that the addition of spray-dried animal plasma (SDAP) affects the palatability of canine food products. Our findings indicate that a 2% SDAP supplementation improves palatability compared to control diets without SDAP. However, the amount of SDAP must be carefully controlled to avoid compromising product palatability, as products with higher concentrations of SDAP (4%) were less preferred by dogs than the control diets (0% SDAP). This study underscores the critical balance required in formulating dog food to enhance both palatability and nutritional value, highlighting the importance of ingredient selection and formulation in creating appealing diets for dogs. Utilizing SDAP as an ingredient in dog food also offers a way to repurpose animal by-products. Further research, including digestibility studies, is needed to understand the long-term effects of SDAP inclusion on the health and well-being of dogs.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/app14177671/s1. Table S1: Preference test scheme.

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