

ASSESSMENT OF PHYSICAL PROPERTIES OF PET-FOOD BASED ON WHEAT MIDLINGS AND MEAT MEAL

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Abstract. Considering the popularity of dry pet food, its market and production are constantly increasing. The quality of the food and the source of raw materials used for its production become as important as in the production of food for human consumption. The aim of the study was to assess the basic physical characteristics of the pet food produced from wheat middlings and meat meal using the extrusion process. The composition of individual samples was as follows: sample A – meat meal 25 %, wheat meal 75 %, moisture content of 30 %; sample B – meat meal 25 %, wheat meal 75 %, moisture content of 25 %; sample C – meat meal 25 %, wheat meal 75 %, moisture content of 20 %; sample D – meat meal 50 %, wheat meal 50 %, moisture content of 30 %; sample E – meat meal 50 %, wheat meal 50 %, moisture content of 25 %; sample F – meat meal 50 %, wheat meal 50 %, moisture content of 20 %. The compounds composed in this way were subject to the extrusion process to obtain characteristic animal cookies. After the initial tests, the following extrusion process parameters were selected: first heater section: 100 °C, second heater section: 120 °C, head: 120 °C, die: oval 2.5/15 mm, 37.5 mm diameter, screw: 800 mm, Ø60 mm., screw rotation: 100 rpm. Properties, such as the degree of expansion, cutting test (biting) and durability, were assessed. The moisture content of raw material before the extrusion process had the highest impact on the physical characteristics of the final product. Statistically significant differences in the cutting test were recorded, depending on the share of individual components and the moisture content.

Keywords: physical properties, extrusion cooking, pet-food, mechanical durability.

Introduction

Extrusion process is used in many branches of food processing. The main assumption of the process is the treatment of raw materials at high temperature and pressure (the so-called barothermic processing). It is widely used in the fodder industry for treating soybean meal, as thanks to the parameters of the extrusion process high content of anti-nutritional compounds present in soybean is eliminated [1].

The market of pet food is developing very quickly, along with the ever increasing number of pets. Additionally, the popularity of dry food increases, as it is considered to be the most favourable when it comes to feeding the animals. In recent years, the source of raw materials used for pet food production became important [2]. Raw materials coming from sustainable farms are increasingly used, and so are fish and seafood originating from sustainable and environmental friendly fishing [3; 4].

The basic components of feed of the pet food type include:

- mixtures of ground grain (maize, wheat, sorghum, and soybeans);
- soybean meal;
- meat meal and meat-and-bone meal;
- animal fats, and others [5].

In sustainable agriculture, it is important to process all by-products, which are produced and can be used for various purposes. Production of different types of biofuels represented by pellets made of oily raw materials is popular in this regard [6-10]. In addition to their purposeful and complete utilization, works are carried out on designing optimal harvesting techniques, fertilization, and even computerized planning of plantings [11-14]. Besides the utilisation and processing rates, also research is carried out in the material quality, content of micro- and macroelements and the impact on the environment [15; 16].

The aim of this study was to produce feed of the pet food type using the extrusion process, and to evaluate the basic strength parameters of the obtained food.

Materials and methods

The test material consisted of 6 different compounds based on meat meal and wheat middlings mixed in various proportions. The research material came from sustainable farms located in Poland.

The composition of each individual compound and its moisture content before the extrusion process is shown below:

In the research, the following designations were adopted:

- sample A – meat meal 25 %, wheat meal 75 %, moisture content of 30 %;
- sample B – meat meal 25 %, wheat meal 75 %, moisture content of 25 %;
- sample C – meat meal 25 %, wheat meal 75 %, moisture content of 20 %;
- sample D – meat meal 50 %, wheat meal 50 %, moisture content of 30 %;
- sample E – meat meal 50 %, wheat meal 50 %, moisture content of 25 %;
- sample F – meat meal 50 %, wheat meal 50 %, moisture content of 20 %.

Before the extrusion process 5kg portions of each compound were weighted, which were humidified to the moisture content of 20 %, 25 % and 30 %, respectively.

These prepared allotments of respective compounds were subject to the extrusion process using a single-screw extruder S-60.

After initial trials the following parameters of the extrusion process were selected:

- first heating section: 100 °C;
- second heating section: 120 °C;
- head: 120 °C;
- die: oval 2.5/15 mm., 37.5 mm in diameter;
- screw: 800mm., Ø60 mm. (L/D = 13.3);
- screw rotational speed: 100 rpm.



Fig. 1. Extruder die head

Moisture content of the material and the obtained food was determined using the dry oven method in accordance to PN-EN-ISO 18134-3:2015-11 standard [17].

Before the extrusion process, the following physical properties of the compounds were assessed:

- angle of repose [18];
- chute angle [19];
- bulk density [20];
- shaken density [20];
- average particle size [21].

Obtained pet food cakes, after drying on screens to the final moisture content of 10 %, were subject to the following tests.

1. The degree of expansion was calculated from the formula:

$$Se = \frac{h \cdot g}{2.5 \cdot 15} \cdot 100$$

where Se – degree of expansion, %;
 h – height of the sample, mm;
 g – thickness of the sample, mm;
 2.5 and 15 – dimensions of the die head, mm.

- The cutting test was performed using a TA.XT plus texture analyser with the blade with cutting edge angle of 45° until the sample was cut into half.
- Kinetic durability of the pet food was measured in accordance with Pfast method PN-R-64834 [22].

Results and discussion

Physical properties of the compounds prior to the extrusion process are shown in Table 1. The obtained compounds had similar physical characteristics, which allows to omit their effect on the extrusion process and the strength properties of the obtained pet food.

Table 1

Physical properties of the raw materials and compounds before the extrusion process

Raw material	Angle of repose, °	Chute angle, °	Bulk density, $\text{kg}\cdot\text{m}^{-3}$	Shaken density, $\text{kg}\cdot\text{m}^{-3}$	Average particle size, mm
Wheat middlings	28	36	587	1107	0.64
Meat meal	35	35	577	1077	0.42
Compound (with 25 % share of meat meal)	31	36	585	1085	0.56
Compound (with 50 % share of meat meal)	33	35	582	1092	0.62

The degree of expansion of the obtained pet food is depicted in Fig. 2. The degree of expansion depended on the moisture content of the compound. The highest degree of expansion was obtained for the compounds with the moisture content of 20 %. It ranged between 1.83 and 1.96 %. In the case of the mixtures with the moisture content of 30 % the degree of expansion was 0.95 and 0.63 % accordingly. As shown by the research results, the degree of expansion is also correlated with the composition of the compound. In the case of compounds with oat sharps and maize meal the degree of expansion ranged from 2 to 4 for the compounds of 30 % and 50 % of oat sharps with maize meal [23].

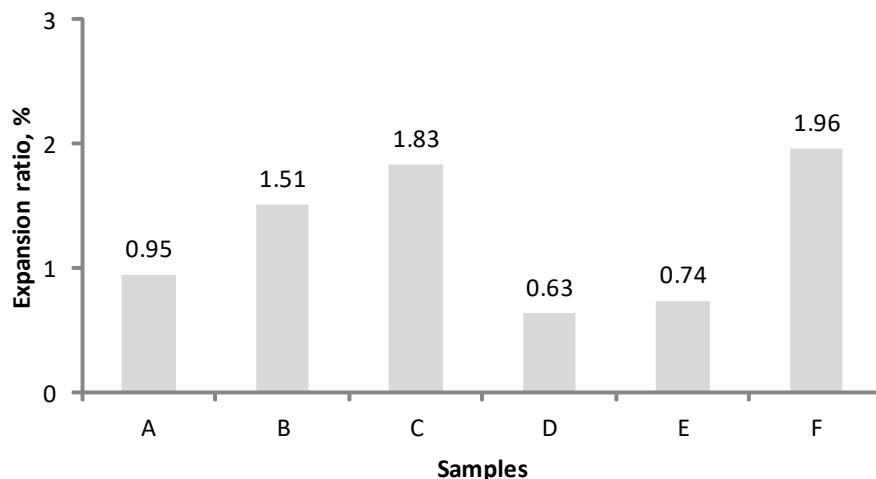


Fig. 2. Degree of expansion of particular samples

When measuring the cutting force for individual pet food an inverse relationship was observed (Fig. 3), i.e. the samples with the moisture content of 30 % were characterised by the highest cutting force of 151.2 N for compound A and 90.1 N for compound D. The samples with lower moisture content (C and F) were characterised by lower cutting force of 23.2 N and 20.2 N, respectively. Sobczak et al. (2007) carried out research on samples with meat meal, soyabean meal, and maize meal [24]. In that study the value of the cutting force for the obtained extrudates varied between 3.6 and 13.4 N, which evidenced high fragility of the samples. In contrast, the compounds of oat sharps, with

admixture of 20 and 30 % of maize meal, subject to the extrusion process were characterized by the cutting force ranging between 10 and 20 N [23; 25].

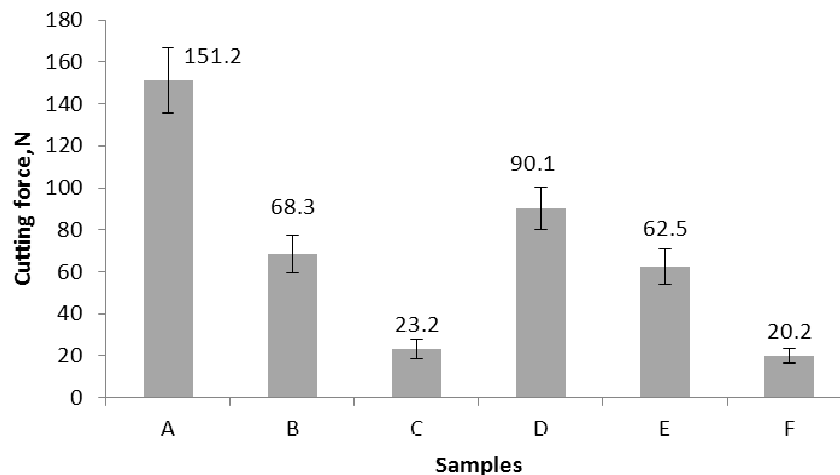


Fig. 3. Value of cutting force with standard deviation for particular samples

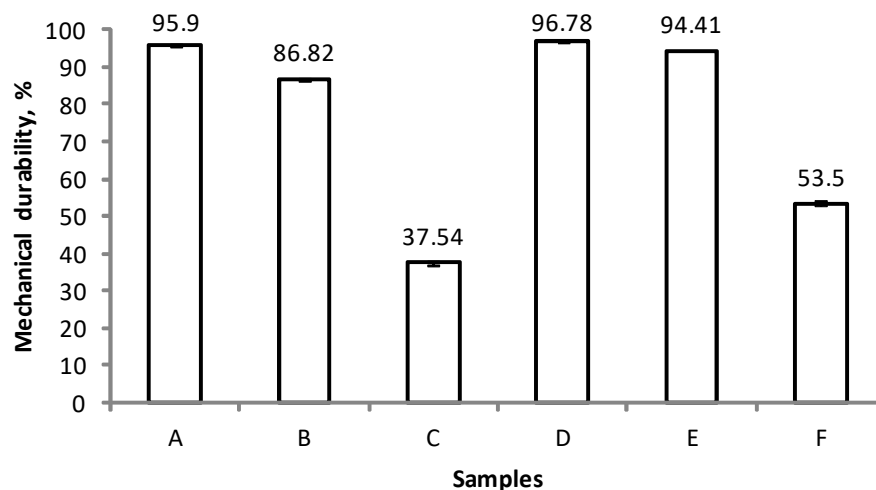


Fig. 4. Mechanical durability of individual samples measured in accordance to Pfast method

The highest mechanical durability of pet food was observed for the samples with the moisture content of 30 % (Fig. 4). In the case of samples with the initial moisture content of 20 %, i.e. samples C and F, a significant decrease of mechanical durability was observed. The samples with the initial moisture content of 25 % were characterised by the mechanical durability of 86.82 % (sample B) and 94.41 % (sample E). Mechanical durability indicates the integrity of pellets and their resistance to pouring. For granulated samples of wheat middlings the mechanical durability was only within the 90-98 % range [24; 26].

Conclusions

1. Initial moisture content of the compounds influences the quality of extruded pet food.
2. In the case of compounds A and C, the increase of the compound moisture content by 50 % (from 20 to 30 %) resulted in an over sevenfold increase of the cutting force, while the mechanical durability of these compounds increased more than twice.
3. When it comes to the degree of expansion, the inverse relationship was observed. The increase of the moisture content of the compound prior to extrusion by 50 % (samples A and C) resulted in reduction of the degree of expansion by half.
4. The share of meat meal, equal to 50 % or 25 %, in the pet food resulted in the change of its durability.

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