The development of technological parameters of seed sprouting before extrusion

I A Chaplygina¹, V V Matyushev, E V Shanina, A V Semenov and Zh N Shmeleva
FSBEI HE Krasnoyarsk state agrarian university, 90, Mira Avenue, Krasnoyarsk, 660049, Russian Federation

¹E-mail: ledam_palustre@mail.ru

Abstract. The optimal combination of seed sprouting and extrusion processes reduces the energy, economic and labor costs of germination and decreases the loss of sprouted seed. To obtain sprouted seed, various pretreatment methods were evaluated before the extrusion process. It was found that the optimal pre-treatment of seeds before sprouting is treatment with microwave radiation of 1400 W/dm³ for 20 s or 3% hydrogen peroxide for 10 min. When using such treatment methods, not only microflora suppression but also activation of the feed seed sprouting process are provided. The first sprouts appear in 12 hours. In 60 hours, the amount of sprouted seeds reaches 70-90%. The length of sprouts at this stage of germination is optimal for further processing and is from 5 to 25 mm.

1. Introduction
The basis of the farm animal diets is grain feed. The lack of biologically active substances in the composition is often compensated by the use of premixes based on synthetic vitamins and mineral components. Such feed components are poorly absorbed by animals’ bodies and can have a negative impact on them [1]. Feed enrichment with natural plant components may be limited due to their chemical composition (for example, anti-nutritional substances of legumes) [2], short storage periods [3], etc. In this regard, an important aspect of obtaining high-quality feed is the use of combined methods of preparing feed components. Methods of components processing are usually aimed at increasing the availability of feed for digestive enzymes of the animal, reducing the negative impact of anti-nutritional substances, increasing the shelf life and manufacturability of use.

Combined preparation methods of feed components include seed sprouting and subsequent extrusion of seed mixtures with pre-sprouting of one of the components [4].

In the process of seed sprouting, the activation of enzymatic processes takes place aimed at providing the sprouts with energy and building material, due to the destruction of the most accessible compounds. At the same time, there is a decrease in the content of sucrose, starch, fat, nitrogen-free extractives [4, 5, 6], anti-nutritional substances are inactivated. At the initial stages of seed sprouting (12-36 hours), the content of vitamins, protein, and monosaccharides increases. During sprouting, it is important to determine the optimal time interval at which the processes of active synthesis of substances prevail over the processes of decomposition.

Using the process of seed mixtures extrusion, due to deep biochemical changes in the raw material, allows to improve the quality of the finished feed and its digestibility by animals [7, 8, 9, 10].
The optimal combination of seed sprouting and extrusion processes reduces the energy, economic and labor costs of germination and decreases the loss of sprouted seed.

In this regard, the research aimed at determining the optimal method of seed sprouting is relevant. To do this, it is necessary to choose a method for preparing the seeds for sprouting, modes and time interval for obtaining sprouts.

2. Objects and methods of research

Experimental studies were conducted at the Engineering center of the Krasnoyarsk state agrarian university.

Forage seeds of corn (Zea mays), soy (Glycine max) and peas (Pisum sativum) grown in the conditions of the educational farm “Minderlinskoe” of the Krasnoyarsk state agrarian university in the Sukhobuzimsky district were used as initial components during the research.

The material for the research was made up of samples taken from 3 seed samples. From each sample for sprouting, 30 g of samples were selected. The research was carried out in threefold repetition. Soaking and sprouting were performed in water at 20±1°C, without access to light.

The seed was disinfected before germination using one of the following methods:

- soaking in 1.5 % potassium permanganate solution for 10 min;
- soaking in 3 % hydrogen peroxide solution for 10 min;
- microwave radiation treatment 1400 W / dm³ for 20 s.

In the control variant the seed was not pre-treated. After treatment, the seed was washed and soaked in water (1: 1 by volume) for 6 hours. After the specified time, it was washed with running water for 1 min and laid out in a layer of 2 cm in a container, filled with water at 1/2 of the seed level. Sprouting was carried out in the dark at a temperature of 20°C for 72 hours (taking into account the soaking time). Every 12 hours, the seed was washed with running water.

Every 12 hours, the amount of sprouted seeds was counted. In 36, 48, 60 and 72 hours from the beginning of sprouting, the length of the sprouts was measured.

3. Results and discussion

During the research, it was noted that in the control variant, in 48 hours of sprouting, the beginning of the mold fungi development is observed, which is expressed in the presence of a characteristic smell, with the visual absence of mycelium. In 72 hours, mold fungi are visually marked on the sprouted seed. When using hydrogen peroxide, potassium permanganate or microwave radiation for the seeds pre-treatment the development of microflora is not observed.

It was revealed that pre-treatment of seeds with hydrogen peroxide or microwave radiation has a positive effect on the sprouting processes (figure 1). It was noted that after treatment with hydrogen peroxide and microwave radiation, the first sprouts appeared in all the studied crops in 12 hours from the beginning of sprouting. When using hydrogen peroxide for pretreatment, the presence of 4% of sprouted seeds is noted for soy, for peas – 9%, for corn – 2%. After treatment with microwave radiation, the amount of sprouted soy was 2 %, peas – 8 %, corn – 4 %. In the control variant and after treatment with potassium permanganate, the beginning of the sprouting process was noted in 24 hours of exposure.

The most positive dynamics of sprouting for soy and peas was observed after pre-treatment with hydrogen peroxide. In 72 hours, the amount of sprouted soy (figure 1a) was 63% in the control variant, 97% in the variants with pre-treatment with hydrogen peroxide, 89% with microwave radiation, and 73% with potassium permanganate.

The similar dynamic was observed during peas sprouting (figure 1b). The amount of sprouted peas in 72 hours of exposure was 82 % in the control variant, 96 % in the variants with pre-treatment with hydrogen peroxide, 90% with microwave radiation, and 83% with potassium permanganate.

When sprouting corn, the greatest positive effect on the germination processes was observed with the use of microwave radiation for pre-treatment (figure 1c). The amount of sprouted corn in 72 hours
of exposure was 77% in the control variant, 93% in the variants with pre-treatment with hydrogen peroxide, 96% with microwave radiation, and 82% with potassium permanganate.

Figure 1. The amount of sprouted seeds depending on the method of the seed pre-treatment: a-soy, b-peas, c-corn.

When sprouting corn, the greatest positive effect on the germination processes was observed with the use of microwave radiation for pre-treatment (figure 1c). The amount of sprouted corn in 72 hours of exposure was 77% in the control variant, 93% in the variants with pre-treatment with hydrogen peroxide, 96% with microwave radiation, and 82% with potassium permanganate.

The dynamics of all crops sprouting after treatment with potassium permanganate did not show significant results in comparison with the control variant.

After using pre-treatment with hydrogen peroxide or microwave radiation, the presence of more than 70% of sprouted seeds was noted in 60 h from the sprouting beginning.

Analysis of changes in the length of sprouts also showed the positive effect of pre-treatment with hydrogen peroxide and microwave radiation (figure 2).

Figure 2. The length of seed sprouts depending on the method of pre-treatment.

In 72 hours from the sprouting process beginning, after pre-treatment with hydrogen peroxide, the length of corn sprouts was 1.9 times, peas 1.5 times, and soybeans 3.8 times higher as compared to the control variant. After the seed treatment with microwave radiation, the length of corn sprouts exceeded the control by 2.7 times, peas – by 1.2, and soybeans – by 2.3 times. After treatment with potassium permanganate, the length of corn, pea and soy sprouts was 1.7, 1.1 and 1.8 times higher, respectively, compared to the control.

Sprouts of corn, peas and soy, after 72 hours of sprouting are shown in figure 3.

One-factor dispersion analysis showed a significant influence of hydrogen peroxide and microwave radiation on the sprouting processes and the length of sprouts of the studied crops.
After pre-treatment with hydrogen peroxide or microwave radiation, the sprouts of all crops reach the optimal length (5 – 25 mm) in 48 – 60 hours of sprouting for further extrusion processing. Given that the optimal amount of sprouted seed (70 % or higher) is observed after 60 hours of sprouting, the duration of seed sprouting for no more than 60 hours can be recommended.

![Sprouts](image)

**Figure 3.** Sprouts (from top to bottom) of corn, soy and peas in 60 h. of sprouting: 1 – control, 2 – treatment with 3 % solution of hydrogen peroxide, 10 min, 3 – treatment with microwave radiation 1400 W / dm³, 20 s. 4 – treatment with 1.5 % solution of potassium permanganate, 10 min.

The humidity of the resulting mass of sprouts is 40-45 %. Mixing up to 30% of sprouted seeds with dry seeds allows to get a mixture of optimal humidity for extrusion.

4. Conclusion

Based on the research, it was found that the optimal pre-treatment of seeds before sprouting is treatment with microwave radiation of 1400 W/dm³ for 20 s or 3% hydrogen peroxide for 10 min. When using such methods of treatment the suppression of the microflora and consequently the safety of the seed in the sprouting process are provided.

Pre-treatment with microwave radiation of 1400 W / dm³ for 20 s or 3 % hydrogen peroxide for 10 min activates the process of feed seed sprouting. The first sprouts appear in 12 hours. In 60 hours, when using microwave radiation for pre-treatment, the amount of sprouted soy reaches 74 %, peas – 79 %, corn – 90 %. When using hydrogen peroxide treatment, the amount of sprouted soy is 92 %, peas – 90 %, corn – 82 %. The length of sprouts at this stage of germination is optimal for further processing and ranges from 5 mm (soy, microwave radiation) to 25 mm (corn, microwave radiation). Thus, the optimal sprouting time is 60 hours.

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