Substantiation of technological approaches to the creation of innovative concentrated food semi-finished flour products

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Abstract. It is known that wheat flour is traditionally used for the preparation of concentrated food semi-finished products, but its protein composition is not balanced by such amino acids as lysine and threonine. To increase the nutritional and biological value of these products, it is necessary to use secondary raw materials obtained in the production of soy flour. The data obtained as a result of the research allow us to establish the possibility and benefits of using binary flour compositions based on soy germ and shell flour in the composition of concentrated food semi-finished flour products. This helps to increase the nutritional and biological value of food products while expanding the range. Recipes and technological schemes for the production of such products are proposed. Developed concentrated food semi-finished products of flour-based food can be used in the preparation of a specialized diet and for therapeutic and preventive purposes to fill the deficit of certain nutrients.

1. Introduction

Currently, a lot of scientists conduct research aimed at improving the nutritional and biological value of functional and specialized food products. They must contain important components for human life that reduce the likelihood of a deficiency of nutrients (vitamins, proteins, macro-and micronutrients, essential fatty acids) in the body [1]. Their lack can lead to disruption of all body systems, make the immune system vulnerable, and increase the likelihood of the occurrence and development of certain diseases.

The problem of enrichment of such products with biologically active components can be solved by using secondary raw materials produced in the production of soy flour, and their proportion should be at least 15 % [2].

A literature and patent search on the problem under consideration showed that this type of raw material in the form of protein-carbohydrate flour (germ, shell, cotyledon, etc.) was not previously used in the production of functional and specialized food products [3-6].

In this regard, there are no scientifically based recommendations for the design of food products of the considered assortment group. Thus, the research on the stated problem has not been carried out before, and accordingly, it is relevant for the modern food industry.

The aim of the research is to substantiate approaches to creating innovative concentrated food semi-finished flour products by establishing the possibility and benefits of using soy germ and shell flour in their composition.
Research problems are:
- to substantiate the nutritional and biological value of binary flour compositions on the basis of data on the biochemical composition of flour products;
- to substantiate recipes for pancakes based on binary flour compositions and develop technological schemes for their production formation.

2. Results
Concentrated food semi-finished products intended for the preparation of flour products are dry mixtures of pre-prepared products: flour, sugar, milk, egg powder and other components.

As a result of comparative analysis of the chemical composition of various crops, it was found out that soy seeds have a great advantage over grains and oilseeds in terms of protein and essential amino acids. Low starch content and, at the same time, a sufficiently large amount of hemicellulose, fiber, pectin make soy indispensable in appropriate and dietary nutrition.

Table 1. Biochemical composition and energy value of flour products

| Flour product | Water, % | Proteins, % | Fats, % | Carbohydrates, % | Mineral substances, % | Energy value, kcal/100 g |
|---------------|----------|-------------|---------|------------------|------------------------|--------------------------|
| Monte and disaccharides starch fiber |
| Soy            | 6.4      | 45.3        | 27.0    | 9.1              | 10.0                   | 2.6                      | 4.1                      | 494.0                   |
| Pease          | 14.0     | 20.5        | 2.0     | 4.6              | 44.0                   | 5.7                      | 2.8                      | 298.0                   |
| Lentil         | 12.0     | 24.0        | 1.5     | 5.0              | 40.2                   | 4.8                      | 0.5                      | 310.0                   |
| Chickpea       | 12.0     | 20.0        | 4.0     | 5.0              | 39.8                   | 5.2                      | 2.0                      | 310.0                   |
| Oat            | 14.0     | 11.0        | 6.1     | 0.9              | 48.8                   | 2.8                      | 2.1                      | 303.0                   |
| Rice           | 14.0     | 7.0         | 1.0     | 0.7              | 70.7                   | 0.4                      | 0.7                      | 330.0                   |
| Buckwheat      | 14.0     | 9.5         | 2.3     | 1.1              | 64.8                   | 1.1                      | 1.3                      | 329.0                   |
| Corn           | 14.0     | 8.3         | 1.2     | 1.2              | 70.4                   | 0.8                      | 0.7                      | 337.0                   |
| Wheat          | 14.0     | 11.0        | 1.2     | 0.8              | 67.5                   | 0.3                      | 0.7                      | 335.0                   |
| Millet         | 14.0     | 12.0        | 2.9     | 1.7              | 64.8                   | 0.7                      | 1.3                      | 340.0                   |
| Barley         | 14.0     | 10.4        | 1.3     | 1.5              | 65.2                   | 1.4                      | 0.7                      | 324.0                   |
| Rye            | 14.0     | 9.0         | 1.5     | 2.0              | 70.7                   | 1.2                      | 1.6                      | 345.5                   |

Table 2. The content of food substances in binary leguminous flour compositions, %, and their energy value, kcal / 100 g

| Flour composition | Water, % | Proteins, % | Fats, % | Carbohydrates, % | Mineral substances, % | Energy value, kcal/100 g |
|-------------------|----------|-------------|---------|------------------|------------------------|--------------------------|
| Soy-pea           | 10.0     | 32.90       | 14.50   | 6.85             | 27.0                   | 1.7                      | 3.45                     | 404.50                  |
| Soy-chickpea      | 9.0      | 34.65       | 14.25   | 7.07             | 25.1                   | 3.7                      | 2.75                     | 407.25                  |
| Soy-lentil        | 9.0      | 32.65       | 15.50   | 7.05             | 24.9                   | 3.9                      | 3.05                     | 413.50                  |

The presence of physiologically valuable and biologically active substances allows us to consider it necessary for therapeutic and preventive purposes.

To increase the nutritional and biological value of products, soy shell and germ flour obtained by...
the KPSM-850 unit was used [2].

The germ and shell fractions obtained in the production of non-fat soy flour or heat-treated soy grits are ground with wheat flour and other recipe ingredients.

Table 1 shows data on the biochemical composition of flour products based on grains and legumes.

Table 2 shows data describing binary flour compositions based on grains and legumes.

From the table data it follows that when composing binary compositions from flour components, there is an improvement in food properties, and it results in the balance of the composition.

As a result of studies of the biochemical composition of such flour products as oat, rice, buckwheat, corn, wheat, barley and rye, we obtained some data that allow us to establish the benefits of their use in the composition of food concentrates of flour products.

Table 3 shows data describing binary flour compositions based on legumes and grains.

Table 4 shows data describing the biological value of flour.

**Table 3.** The content of the main food substances in flour binary compositions, % and their energy value, kcal / 100 g

| Flour composition | Water, % | Proteins, % | Fats, % | Carbohydrates, % | Mineral substances, % | Energy value, kcal/ 100 g |
|-------------------|----------|-------------|--------|------------------|-----------------------|--------------------------|
|                   |          |             |        | mono - and        |                       |                          |
|                   |          |             |        | disaccharides    |                       |                          |
| Soy-oat           | 9.6      | 24.6        | 14.5   | 2.54             | 33.30                 | 2.68                     | 2.90                     | 382.90                  |
| Soy-rice          | 10.8     | 22.2        | 11.4   | 2.42             | 46.40                 | 1.24                     | 2.06                     | 393.00                  |
| Soy-buckwheat     | 10.8     | 23.7        | 12.1   | 2.66             | 43.00                 | 1.66                     | 2.42                     | 391.80                  |
| Soy-corn          | 10.8     | 22.9        | 11.5   | 2.72             | 46.00                 | 1.48                     | 2.06                     | 395.20                  |
| Soy-wheat         | 10.8     | 24.6        | 11.5   | 2.48             | 44.00                 | 1.12                     | 2.06                     | 392.40                  |
| Soy-millet        | 10.8     | 25.2        | 11.8   | 3.00             | 42.00                 | 1.42                     | 2.44                     | 392.60                  |
| Soy-barley        | 10.8     | 24.2        | 11.5   | 2.90             | 43.00                 | 1.56                     | 2.06                     | 390.00                  |
| Soy-rye           | 12.0     | 24.6        | 11.7   | 4.20             | 43.46                 | 1.76                     | 2.28                     | 401.38                  |

**Table 4.** Content of essential amino acids (A, g / 100g) and amino acid score (S, %) of flour proteins

| Essential amino acids (EAA) | the standard of FAO/WHO | Pea | Chickpea | Lentil |
|-----------------------------|-------------------------|-----|----------|--------|
| A                           | C                       | A   | C        | A      | C     | A      | C     |
| Valine                      | 5.0                     | 100.0 | 4.94 | 98.8 | 3.92 | 78.4 | 5.29 | 105.8 |
| Isoleucine                  | 4.0                     | 100.0 | 4.30 | 107.0 | 3.19 | 79.7 | 4.25 | 106.2 |
| Leucine                     | 7.0                     | 100.0 | 8.88 | 126.0 | 7.35 | 105.0 | 7.88 | 112.5 |
| Lysine                      | 5.5                     | 100.0 | 7.06 | 128.0 | 3.97 | 72.1 | 7.17 | 130.3 |
| Methionine+cystine          | 3.5                     | 100.0 | 2.25 | 64.2 | 1.67 | 47.7 | 2.13 | 60.8 |
| Threonine                   | 4.0                     | 100.0 | 4.06 | 101.5 | 3.06 | 76.5 | 4.00 | 100.0 |
| Phenylalanine+tyrosine      | 6.0                     | 100.0 | 7.51 | 125.0 | 6.35 | 105.8 | 8.56 | 142.6 |
| Tryptophan                  | 1.0                     | 100.0 | 1.12 | 112.0 | 0.71 | 71.0 | 0.92 | 92.0 |
| Σ EAA                       | 36.0                    | 100.0 | 40.10 | 111.4 | 30.22 | 83.9 | 40.2 | 111.6 |

Table 5 shows the recipe for concentrated food semi-finished flour products “Special pancakes” in three variants.
Table 5. Recipe of concentrated food semi-finished flour products “Special pancakes”

| Ingredients             | The content by variants, % |
|-------------------------|----------------------------|
|                         | # 1 | # 2 | # 3 |
|                         | pea-soy | lentil-soy | chickpea-soy |
| Soy shell flour         | 20.00 | 20.0 | -   |
| Pea flour               | 20.00 | -   | -   |
| Lentil flower           | -    | 20.0 | -   |
| Chickpea flower         | -    | -   | 20.0|
| Baking wheat flour      | 60.00 | 60.00| 60.00|
| Egg powder              | 1.00  | 1.00 | 1.00|
| Whole milk powder       | 3.00  | 3.00 | 3.00|
| Baking soda             | 0.40  | 0.40 | 0.40|
| Citric acid             | 0.20  | 0.20 | 0.20|
| Food salt               | 1.00  | 1.00 | 1.00|
| Ginger                  | 0.01  | 0.01 | 0.01|
| Turmeric                | 0.01  | 0.01 | 0.01|

Table 5 shows comparative data on the biochemical composition of pancakes according to developed and traditional recipes.

Table 6. Comparative characteristics of concentrated food semi-finished products (CFSP) of flour products “Special pancakes” in food substances (FS)

| CFSP name          | Content      | micronutrients, mg / 100 g | Energy value, kcal / 100 g |
|--------------------|--------------|-----------------------------|-----------------------------|
|                    | main substance, % | FS mineral substances | |
|                    | proteins | fats | carboh ydrates | FS | mineral substances | ferrum | zinc | |
| Pea-soy pancakes   | 14.1      | 1.2  | 68.7          | 10.6 | 2.0             | 8.0 | 2.8 | 342.0 |
| Lentil-soy pancakes| 14.0      | 1.3  | 68.8          | 10.0 | 2.1             | 8.0 | 2.9 | 342.7 |
| Chickpea-soy pancakes | 14.2 | 1.3  | 68.3          | 10.0 | 2.3             | 8.0 | 2.9 | 340.7 |
| Homemade pancakes Specs 9195-002-00948532-04 | 10.0  | 1.0  | 73.0          | - | 0.9             | - | - | 340.0 |

Table 6 shows comparative data on the biochemical composition of pancakes according to developed and traditional recipes.

Table 7 shows comparative data on the degree of satisfaction of the daily physiological need (DPN) of a person in food nutrients.
Table 7. Comparative characteristics of the CFSP of flour products “Special pancakes” according to the degree of satisfaction of human DPN in food nutrients

| FCS name                     | The degree of satisfaction of DPN, % | in proteins | in lipids | in carbohydrates | in FS | in ferrum | in zinc |
|------------------------------|-------------------------------------|-------------|-----------|------------------|------|-----------|--------|
| Pea-soy pancakes             | 14.1                                | 1.2         | 13.7      | 40.0             | 53.3 | 18.6      |
| Lentil-soy pancakes          | 14.0                                | 1.3         | 13.7      | 40.0             | 53.3 | 19.3      |
| Chickpea-soy pancakes        | 14.2                                | 1.3         | 13.6      | 40.0             | 53.3 | 19.3      |
| Homemade pancakes            | 10.0                                | 1.0         | 14.6      | -                | -    | -         |
| Specs 9195-002-00948532-2004 |                                    |             |           |                  |      |           |

Figure 1 shows the technological scheme of production of CFSP of flour products "Special pancakes".

According to the technological scheme, soy flour previously obtained from the shell fraction is mixed with wheat flour in a percentage ratio of 20:60, respectively. 20% of flour of vegetable origin in accordance with the variant of the recipe is added and then other recipe ingredients are dosed. The ingredients are mixed and ready-made concentrated food semi-finished products of flour products are packed.

Table 8 shows the developed recipes for concentrated food semi-finished products "Diet Pancakes" in ten variants, and tables 9 and 10 present their comparative characteristics by composition and degree of satisfaction of the daily physiological need of a person for food substances.
Table 8. Recipe of concentrated food semi-finished flour products “Diet pancakes”

| Ingredients          | Pea-soy pancakes | Lentil-soy pancakes | Chickpea-soy pancakes | Oat-soy pancakes | Rice-soy pancakes | Buckwheat-soy pancakes | Corn-soy pancakes | Wheat-soy pancakes | Barley-soy pancakes | Rye-soy pancakes |
|----------------------|------------------|---------------------|-----------------------|------------------|-------------------|-----------------------|-------------------|-------------------|---------------------|------------------|
| Soy germ flour       | 25.0             | 25.0                | 25.0                  | 25.0             | 25.0              | 25.0                  | 25.0              | 25.0              | 25.0                | 25.0             |
| Pea flour            | 25.0             | -                   | -                     | -                | -                 | -                     | -                 | -                 | -                   | -                |
| Lentil flour         | -                | 25.0                | -                     | -                | -                 | -                     | -                 | -                 | -                   | -                |
| Chickpea flour       | -                | -                   | 25.0                  | -                | -                 | -                     | -                 | -                 | -                   | -                |
| Oatmeal flour        | -                | -                   | -                     | 25.0             | -                 | -                     | -                 | -                 | -                   | -                |
| Rice flour           | -                | -                   | -                     | -                | 25.0              | -                     | -                 | -                 | -                   | -                |
| Buckwheat flour      | -                | -                   | -                     | -                | -                 | 25.0                  | -                 | -                 | -                   | -                |
| Corn flour           | -                | -                   | -                     | -                | -                 | -                     | 25.0              | -                 | -                   | -                |
| Millet flour         | -                | -                   | -                     | -                | -                 | -                     | -                 | 25.0              | -                   | -                |
| Barley flour         | -                | -                   | -                     | -                | -                 | -                     | -                 | -                 | 25.0                | -                |
| Rye flour            | -                | -                   | -                     | -                | -                 | -                     | -                 | -                 | -                   | 25.0             |
| Wheat flour of the highest grade | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 |
| Egg powder           | 1.0              | 1.0                 | 1.0                   | 1.0              | 1.0               | 1.0                   | 1.0               | 1.0               | 1.0                 | 1.0              |
| Whole milk powder    | 3.0              | 3.0                 | 3.0                   | 3.0              | 3.0               | 3.0                   | 3.0               | 3.0               | 3.0                 | 3.0              |
| Baking soda          | 0.4              | 0.4                 | 0.4                   | 0.4              | 0.4               | 0.4                   | 0.4               | 0.4               | 0.4                 | 0.4              |
| Citric acid          | 0.2              | 0.2                 | 0.2                   | 0.2              | 0.2               | 0.2                   | 0.2               | 0.2               | 0.2                 | 0.2              |
| Granulated sugar     | 3.2              | 3.2                 | 3.2                   | 3.2              | 3.2               | 3.2                   | 3.2               | 3.2               | 3.2                 | 3.2              |
| Salt                 | 1.6              | 1.6                 | 1.6                   | 1.6              | 1.6               | 1.6                   | 1.6               | 1.6               | 1.6                 | 1.6              |
Table 9. Comparative characteristics of concentrated food semi-finished products (CFSP) of flour products "Diet pancakes" in food substances

| CFSP name          | Content                        | Main substances, % | vitamin E, mg / 100 g | Energy value, kcal / 100 g |
|-------------------|--------------------------------|--------------------|-----------------------|---------------------------|
|                   | proteins | fats     | carbohydrates | FS | mineral subst. |                      |                       |
| Pea-soy pancakes  | 18.0     | 5.1      | 60.1         | 0.5 | 2.8           | 8.0                 | 358.3                 |
| Lentil-soy pancakes | 17.9   | 4.9      | 60.5         | 0.5 | 2.7           | 8.1                 | 357.7                 |
| Chickpea-soy pancakes | 17.1  | 4.9      | 75.3         | 0.6 | 2.7           | 8.0                 | 413.7                 |
| Oat-soy pancakes  | 15.2     | 4.4      | 77.9         | 0.5 | 2.5           | 7.5                 | 411.3                 |
| Rice-soy pancakes | 14.9     | 4.2      | 77.8         | 0.5 | 3.1           | 7.8                 | 408.4                 |
| Buckwheat-soy pancakes | 15.5  | 4.7      | 77.9         | 0.5 | 1.9           | 8.0                 | 415.9                 |
| Corn-soy pancakes | 15.1     | 4.3      | 78.8         | 0.5 | 1.8           | 7.9                 | 414.3                 |
| Wheat-soy pancakes | 15.0    | 5.1      | 77.3         | 0.6 | 2.6           | 7.9                 | 415.1                 |
| Barley-soy pancakes | 14.3   | 4.4      | 79.1         | 0.5 | 2.2           | 7.3                 | 413.2                 |
| Rye-soy pancakes  | 14.4     | 4.2      | 79.9         | 0.5 | 1.5           | 7.2                 | 415.0                 |
| Homemade pancakes Specifications | 10.0  | 1.0      | 73.0         | 0.5 | 0.9           | -                   | 340.0                 |

Table 10. Comparative characteristics of CFSP of flour products "Diet pancakes" according to the degree of satisfaction of human DPN in food nutrients

| CFSP name          | The degree of satisfaction of DPN, % |
|-------------------|--------------------------------------|
|                   | in proteins | in lipids | in carbohydrates | in FS | in vitamin E |
| Pea-soy pancakes  | 18.0        | 5.1       | 12.0           | -    | 40.0        |
| Lentil-soy pancakes | 17.9       | 4.9       | 12.1           | -    | 40.5        |
| Chickpea-soy pancakes | 17.1      | 4.9       | 15.1           | -    | 40.0        |
| Oat-soy pancakes  | 15.2        | 4.4       | 15.6           | -    | 37.5        |
| Rice-soy pancakes | 14.9        | 4.2       | 15.5           | -    | 39.0        |
| Buckwheat-soy pancakes | 15.5     | 4.7       | 15.6           | -    | 40.0        |
| Corn-soy pancakes | 15.1        | 4.3       | 15.8           | -    | 39.5        |
| Wheat-soy pancakes | 15.0        | 5.1       | 15.5           | -    | 39.5        |
| Barley-soy pancakes | 14.3       | 4.4       | 15.8           | -    | 36.5        |
| Rye-soy pancakes  | 14.4        | 4.2       | 16.0           | -    | 36.0        |
| Homemade pancakes | 10.0        | 1.0       | 14.6           | -    | -           |

Figure 2 shows the technological scheme of production of flour products "Diet pancakes". According to the technological scheme, soy flour previously obtained from germ fractions is mixed with wheat flour in a percentage ratio of 25:50, respectively. 25 % of flour of vegetable origin in accordance with the variant of the recipe is added and then other recipe ingredients are dosed. The
ingredients are mixed and ready-made concentrated food semi-finished products of flour products are packed.

![Figure 2. Technological scheme of production of flour products "Diet pancakes"](image)

### 3. Conclusion

As a result of the conducted research, we revealed the possibility and benefits of using binary flour compositions based on soy germ and shell flour when creating recipes for concentrated food semi-finished flour products in the form of mixtures for baking "Special pancakes" and "Diet pancakes". By their example, it was found out that flour products with soy flour have a high biological value due to the presence of iron, zinc and vitamin E. The technological schemes for the production of the expanded range of food products were developed based on reasonable approaches.

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