GSC Advanced Research and Reviews

eISSN: 2582-4597 CODEN (USA): GARRC2

Cross Ref DOI: 10.30574/gscarr

Journal homepage: https://gsconlinepress.com/journals/gscarr/

(Research Article)

Check for updates

Effect of yellow soybean and green soybean flours (*Glycine max* and *Glycine hispida*) on nutritional performance in growing Wistar strain rats

DIBY Yao Bernard [1,*], KAHOU BI Gohi Parfait [1], KASSIM Dosso [2] and YAPO Angoue Paul [3]

[1] Jean Lorougnon GUEDE University, Training and Research Unit of Agroforestory, Laboratory of Agrovalorisation, PO Box 150 Daloa, Côte d'Ivoire.

[2] Jean Lorougnon GUEDE University, Training and Research Unit of Environment, Laboratory of Biodiversity and Tropical Ecology, PO Box 150 Daloa, Côte d'Ivoire.

[3] Nangui ABROGOUA University, Nature Sciences Training and Research Unit, Laboratory of Physiology, Pharmacology and Pharmacopoeia, PO Box 801 Abidjan 02, Côte d'Ivoire.

GSC Advanced Research and Reviews, 2025, 24(03), 307-316

Publication history: Received on 17 August 2025; revised on 23 September 2025; accepted on 26 September 2025

Article DOI: https://doi.org/10.30574/gscarr.2025.24.3.0291

Abstract

Soybean flour is often used in human food. This study aims to evaluate the nutritional impact of this meal made from two varieties of soybeans (*Glycine max* and *Glycine hispida*) with a view to promoting its consumption. To achieve this, the chemical composition of the flour from both soybean varieties was determined, and then a twelve (12) day animal experiment was conducted on fifteen (15) rats divided into three groups of five rats each. These rats are fed diets formulated with fish (RP) for the control group and two soybean-based diets, yellow soybean (RSJ) and green soybean (RSV), for the test groups. The results indicate that the chemical composition of yellow soybean flour differs from that of green soybean flour in terms of organic nutrient levels. Yellow soybeans contain carbohydrates (21.52%), lipids (15.01%), proteins (32.22%), fiber (14.10%), and a low moisture content (7.25%), while green soybeans contain carbohydrates (48.15%), lipids (1.32%), proteins (24.55%), fiber (17.05%), and a low water content (8.85%). This difference is also evident in the mineral nutrients, where yellow soybeans contain calcium (224.32 mg), potassium (442.31 mg), iron (13.06 mg), and magnesium (250.8 mg), while green soybeans contain calcium (132.65 mg), potassium (362 mg), iron (6.45 mg), and magnesium (192.47 mg). In terms of nutrition, no significant differences were observed in ingested total dry matter (MSTI) among rats fed the different diets. Thus, the MSTI values for RP, RSJ and RSV are 8.02 ± 0.39 g/day, 6.86 ± 0.08 g/day, and 7.26 ± 0.15 g/day, respectively. This same observation was also noted in terms of the coefficient of feed efficiency (CEA), where the respective values are RP (0.31 ± 0.01), RSJ (0.25 ± 0.007), and RSV (0.28 ± 0.007). However, in terms of apparent digestibility, this index is higher in RP rats than in RSJ and RSV rats. These results confirm the benefits of consuming soy as an alternative source of foods rich in nutrients that are essential for the body's well-being.

Keywords: Yellow Soybeans; Green Soybeans; Diet; Rats; Nutritional Performance

1. Introduction

Malnutrition is a serious public health issue affecting millions of people worldwide, especially children. It manifests itself in deficiencies, excesses, or imbalances in energy and/or nutritional intake [1]. Thus, to satisfy his vital needs, man has always drawn on his immediate environment to satisfy this fundamental need in his close relationship with the living beings with whom he shares the same space [2]. Faced with these challenges, humans engage in subsistence farming, growing food crops to satisfy the fundamental need for good nutritional practices to address health concerns. Plants proteins are now regarded as versatile functional ingredients or as biologically active components more than as

* Corresponding author: DIBY Yao Bernard

essential nutrients in the developed countries. Plant food diets increase the level of fibre intake which reduces the risk of bowel diseases [3]. It therefore seems imperative that certain plant varieties with high nutritional qualities are integrated into both rural and urban environments [4]. This variety includes yellow soybeans (*Glycine max*) and green soybeans (*Glycine hispida*), which are annual plants belonging to the legume family [5]. Long considered "the meat of the poor," soy is a multifunctional oilseed and protein crop. It provides protein (30-40%), oil (20%), and carbohydrates (21%) for human and animal consumption [6 ;7]. Soybeans are said to be the plant with the highest protein content compared to other plant and animal species and eggs [8]. Furthermore, soybean protein has a significant amount of lysine, a nutrient that is lacking in most cereals. By adding soybean protein to cereal flour, the nutritional value of the grain is enhanced [9]. It would therefore represent an enormous nutritional resource for populations in developing countries [10]. Its seeds are used in various ways in food. They would be used to produce milk, yogurt, soy cream, soy oil, flour, beer, hot dogs, adhesives, margarine, and other derivative products [11]. Apart from these various dietary uses, some studies have shown that incorporating this legume into diets significantly affects growth, body composition, and levels of various health biomarkers such as blood lipids, glucose, and oxidative stress markers [12]. This study aims to assess the effects of yellow soybean (*Glycine max*) and green soybean (*Glycine hispida*) flours on growth performance, feed utilization, and organ health in growing Wistar rats. The ultimate goal is to determine their suitability as alternative, nutrient-rich food sources that can contribute to improved dietary practices and the fight against malnutrition.

2. Materials and methods

2.1. Plant

Yellow soybean seeds (*Glycine max* L. Merr.) and green soybean seeds (*Glycine hispida* Moench Maxim.) were used as plant material in this study. They were purchased at the Anono market in the municipality of Cocody (Côte d'Ivoire), stored in clean jars, and then transported to the laboratory of the Abidjan Teacher Training College, where they were ground into flour using a Biatone blender.

2.2. Animal

The animals used in this study were fifteen (15) growing rats belonging to the species Rattus norvegicus of the Muridae family. They are four weeks old with an average weight of approximately 40 ± 2 g. These animals come from the animal facility at the Abidjan Teacher Training College, Cocody (Côte d'Ivoire). In this animal facility, all animals were fed pellets with water ad libitum and were treated according to good laboratory practices [13].

2.3. Food products

Various ingredients were used to formulate the diets. Maize seeds purchased at the Anono market and sugar purchased at the supermarket were the main sources of carbohydrates. Dried fish (Hareng) also purchased at the Anono market, is used as a reference source of protein. The "VERA" sunflower oil purchased at the supermarket provided an additional source of energy and fatty acids. Finally, the premix (VITAFLASH) purchased from a veterinary store was used as a source of micronutrients.

2.4. Methods

2.4.1. Determination of the chemical composition of yellow soybean and green soybean flour

Dosages were performed according to AOAC methods. The samples were analyzed three times to determine moisture, protein, fat, carbohydrates, fiber, and minerals (calcium, iron, magnesium, potassium). For moisture content, the method used is that of [14]. To this end, 5 g of each sample is dried in an oven at 105°C for 4 hours, and the difference in weight gives the moisture content. For proteins, their content in each sample was determined using the Kjeldahl method [15]. Lipids are extracted using a non-miscible solvent (n-hexane) in a Soxhlet extractor (Unid Tecator, System HT2 1045, Sweden). After evaporation of the solvent and weighing of the capsule in an oven at 105°C for 30 minutes, the difference in weight gives the lipid content of each sample [14]. Next, the ash content of each sample is determined using the method described in [14]. Each sample is first carbonized on a Bunsen burner and then incinerated in an oven at 600°C for 6 hours. Carbohydrates are determined using the method described in [15] according to the formula: Carbohydrates = 100 - (Water + protein + lipids + ash). Finally, the mineral content (Ca, Fe, K, Mg) is determined on 1 g of each sample after mineralization, dilution, and reading with an atomic absorption spectrophotometer using a Pelkin Elmer device (PE 3110, Norwalk, USA).

2.4.2. Formulation of different diets

The different diets were prepared according to the method described by [16]. These RP, RSJ, and RSV diets were formulated using conventional ingredients such as fish flour, Maize flour, "godio" bread flour, yellow soybean flour, green soybean flour, table salt, vitamin premix, and sunflower oil. The fish-based RP diet serves as the control. RSJ and RSV are formulated from yellow soybeans and green soybeans, respectively. Thus, the preparation of the different diets consisted of mixing the various ingredients in a bowl, taking into account the quantities mentioned in Table 1 below. Distilled water was then added to the mixture to form a malleable, homogeneous paste that was more or less round in shape in order to minimize waste.

Table 1 Composition of different diets

Ingredients	**Diets**		
	RP	RSJ	RSV
Fish (Haring) flour (g)	50	0	0
Yellow soybean flour (g)	0	50	0
Green soybean flour (g)	0	0	50
"Goddio" bread flour (g)	20	20	20
Maize flour (g)	25	25	25
Sunflower oil (g)	2	2	2
Salt (g)	1	1	1
Vitamin Premix	2	2	2
Total	100	100	100

RP: Fish-based diet; RSJ: Yellow soybean-based diet; RSV: Green soybean-based diet

2.4.3. Experimental conduct and measurements taken

The diets were prepared by mixing the various ingredients in a bowl, taking into account the quantities mentioned in the table above. A certain amount of water was added to the mixture in order to obtain food in the form of a purée and minimize waste. The animal growth experiment took place over a period of fifteen (15) days, including three (3) days of adaptation during which the animals were fed a standard diet of Ivograin® pellets. Throughout the experimental period itself, the animals are fed the formulated diets once a day ad libitum every day from 8 a.m. onwards. Clean water is also provided ad libitum and replaced every two days. All animals are weighed at the start of the experiment and then at two-day intervals until the end of the period. The growth rate is determined by calculating the difference between the initial weight and the final weight. Then, the difference between the quantities of food served and the quantities remaining is reported in terms of dry matter to determine the quantities consumed.

2.4.4. Removal and weighing of organs regulating nutrition

At the end the fifteen days, all animals were anesthetized and then sacrificed for removal of the liver, kidneys, spleen, heart, and ileum.

2.4.5. Expression of nutritional value study parameters

These parameters are listed in Table 2 below

Table 2 Expression of nutritional value study parameters

Parameters	Mathematical expressions
Ingested total dry matter (M.S.T.I.)	Total amount of dry matter (from food ingested during the experimental period/ Number of days of the experiment
Growth rate (T.C.)	T.C. (%) = (Maj – Mi) x 100/ Mi
Weight gain (G.P.)	Final weight – initial weight/ Number of days of experiment
Coefficient of feed efficiency (C.E.A.)	C.E.A. = G.P. (g)/ M.S.T.I. (g)
Apparent digestibility (Dia)	Dapp = (I – F)/ I
Relative weight of the organ	Organ weight (g) x 100/ Final live weight of the animal (g)

M.S.T.I: Ingested total dry matter; T.C: Growth rate; C.E.A: Coefficient of feed efficiency; G.P.: Weight gain; D.app: Apparent digestibility; I: Quantity of food consumed; F: Quantity of faeces excreted

2.4.6. Statistical analyses

GraphPad Prism software version 5.0 (Microsoft, San Diego, California, USA) was used for statistical analysis of the data. This analysis was combined with a single-factor ANOVA. The data obtained are presented as mean ± standard error of the mean (M ± esm) and were processed using the Turkey-Kramer test. The difference between the means is considered statistically significant at the 5% threshold ($p<0.05$).

3. Results

3.1. Chemical composition of yellow soybean and green soybean flour

Analysis of the chemical composition of yellow soybean and green soybean flour shows that they contain organic nutrients, minerals, and water, which vary depending on the species. Organic nutrients are represented by carbohydrates, lipids, and proteins at levels of 21.52 ± 0.22; 15.01 ± 0.10; 32.25 ± 1.25% for yellow soybeans and 48.15 ± 1.3; 1.32 ± 0.01 and 24.55 ± 1.12% for green soybeans. In addition to these organic nutrients, other compounds are present, such as fiber, at a rate of 14.10 ± 0.1% for yellow soybeans and 17.05 ± 0.11% for green soybeans. In terms of mineral nutrients, yellow soybeans contain calcium (224.32 ± 4.32 mg), magnesium (250.8 ± 3.52 mg), iron (13.06 ± 2.11 mg), and potassium (442.31 ± 6.42 mg). Similarly, green soybeans also contain calcium (132.65 ± 2.22 mg), magnesium (192.47 ± 2.33 mg), iron (6.45 ± 1.52 mg), and potassium (362 ± 5.28 mg). Finally, the water content in yellow soybeans and green soybeans is approximately 7.25 ± 0.12% and 8.85 ± 1.01%, respectively.

Table 3 Chemical composition of yellow soybean and green soybean seeds flour

Parameters	Content	
	Yellow soybeans	Green soybeans
Humidity (%)	7.25 ± 0.12	8.85 ± 1.01
Dry matter (%)	92.55 ± 1.2	91.15 ± 1.1
Carbohydrates (%)	21.52 ± 0.22	48.15 ± 1.3
Lipids (%)	15.01 ± 0.10	1.32 ± 0.01
Proteins (%)	32.25 ± 1.25	24.55 ± 1.12
Fiber (%)	14.10 ± 0.1	17.05 ± 0.11
Ca (mg)	224.32 ± 4.32	132.65 ± 2.22
K (mg)	442.31 ± 6.42	362 ± 5.28
Fe (mg)	13.06 ± 2.11	6.45 ± 1.52
Mg (mg)	250.8 ± 3.52	192.47 ± 2.33

Ca: Calcium, K: Potassium, Fe: Fer et Mg: Magnesium

3.2. Nutritional parameters for growth

3.2.1. Ingested total dry matter

Ingested total dry matter (MSTI) of the rats in the control group (RP) was 8.02 ± 0.39 g/day. This value is slightly different from those obtained with soy-based diets, whose respective values are 6.86 ± 0.08 for RSJ and 7.26 ± 0.15 g/day for RSV (Table 3). Statistical analysis shows that the consumption levels of rats fed a diet based on yellow soybeans and green soybeans are not significant compared to those of rats fed a fish-based diet.

3.2.2. Coefficient of feed efficiency

The control diet has a higher coefficient of feed efficiency (0.31 ± 0.01) than the yellow and green soybean-based diets. The respective CEA values for RSJ and RSV are 0.25 ± 0.007 and 0.28 ± 0.007 (Table 4). These values reveal that the different diets formulated have similar yields after assimilation, as they are statistically insignificant ($p>0.05$).

Table 4 Consumption parameters for rats subjected to different diets

Nutritional parameters	**diets**		
	RP	**RSJ**	**RSV**
MSTI (g)	96.24 ± 3.36	82.36± 1.23[a]	87.20± 1.06[a]
MSTI (g/day)	8.02 ± 0.39	6.86 ± 0.08[a]	7.26 ± 0.15[a]
CEA	0.31 ± 0.01	0.25 ± 0.007[a]	0.28 ± 0.007[a]

Values are means ± standard errors, with each batch comprising 5 animals (n=5/group). The comparison was performed using one-way analysis of variance (ANOVA 1) followed by Tukey's test (ANOVA 1); $p>0.05$ no significant difference; RP: Fish-based diet; RSJ: Yellow soybean-based diet; RSV: Green soybean-based diet; MSTI: Ingested total dry matter; CEA: coefficient of feed efficiency

3.3. Amount of food consumed by rats

3.3.1. Amount of food consumed by rats

The amount of food consumed by animals varies depending on their diet. In general, animals fed the fish-based diet (RP) consumed more feed than those fed the yellow and green soybean-based diets throughout the duration of the experiment. The animals' consumption of the fish-based diet was constant at the beginning, with a high value of 70 g per day, then decreased slightly until the end of the experiment to reach 56 g. As for diets based on yellow soybeans and green soybeans, animal consumption varied slightly throughout the experimental period, with the highest respective values being 52 g and 56 g (Figure 1).

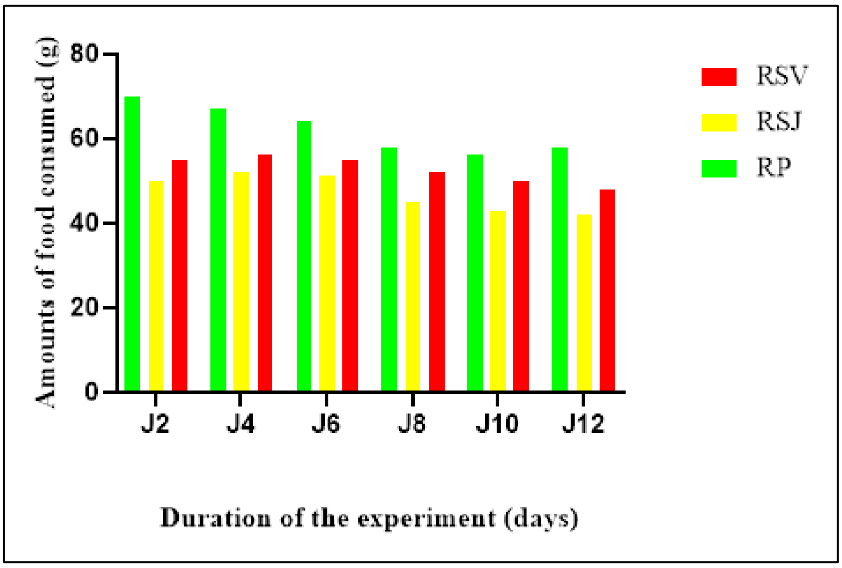

Figure 1 Amount of food consumed by rats according to diet

3.3.2. Weight change and weight gain in rats

Data analysis shows a significant change ($p<0.05$) in body mass in all animals subjected to the different diets compared to their initial mass. Rats fed the fish-based diet (RP) showed the highest weight gain, reaching 70.12 ± 4.39 g at the end of the 12-day experiment, representing a growth rate of approximately 74.42%. This result is followed by that of the rats in the group fed a green soybean-based diet (RSV), whose weight gain was 65.21 ± 3.81 g, representing a growth rate of 62.21%. Finally, the animals in the group fed a yellow soybean-based diet (RSJ) had a final average body weight of 60.49 ± 4.48, representing a growth rate of 51.22% (Table 5). The average daily weight gains of rats varied depending on the type of diet. Thus, rats fed diets based on yellow soybeans and green soybeans had average daily weight gains of 0.65 ± 0.02 g/day and 0.75 ± 0.02 g/day, respectively. As for those on the fish-based diet, the average daily weight gain is the highest at 1.01 ± 0.02 g/day. (Figure 2).

Table 5 Weight characteristic

Diets	Weight characteristic		
	Body mass (g)	Growth rate (%)	Increase in body mass (g)
RP (D0-D12)	70.12 ± 4.39**	+ 74.42	29.92
RSJ (D0-D12)	60.49 ± 4.48^{ns}	+ 51.22	20.59
RSV (D0-D12)	65.21 ± 3.81*	+ 62.21	25.01
Probability	P<0.05		

Values are means ± standard errors, with each batch comprising 5 animals (n=5/group). The comparison was performed using one-way analysis of variance (ANOVA 1) followed by Tukey's test (ANOVA 1); ns: not significant; * p<0.05; ** p<0.01; RP: Fish-based diet; RSJ: Yellow soybean-based diet; RSV: Green soybean-based diet; MSTI: Ingested total dry matter; CEA: coefficient of feed efficiency

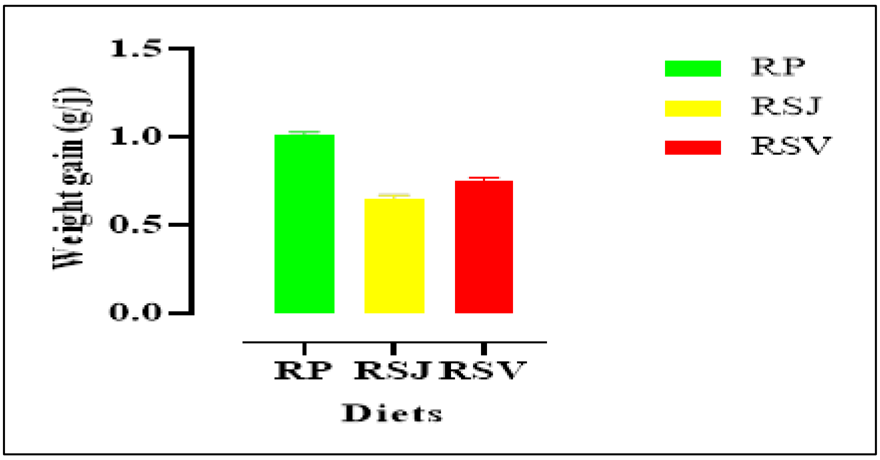

Figure 2 Weight gain of rats fed different diets

3.3.3. Digestibility of different diets

The study of the digestibility of different diets shows that the digestibility index varies from one diet to another. Rats fed the fish-based diet (RP) showed the best digestibility index throughout the experimental period, with the highest value being 17.10 ± 1.1. This result is followed by that of rats fed a green soybean diet (RSV) with a digestibility index of 15.2 ± 1.01. The lowest digestibility index was observed in rats fed the yellow soybean diet (RSJ), with a value of 9.50 ± 0.2 (Figure 3).

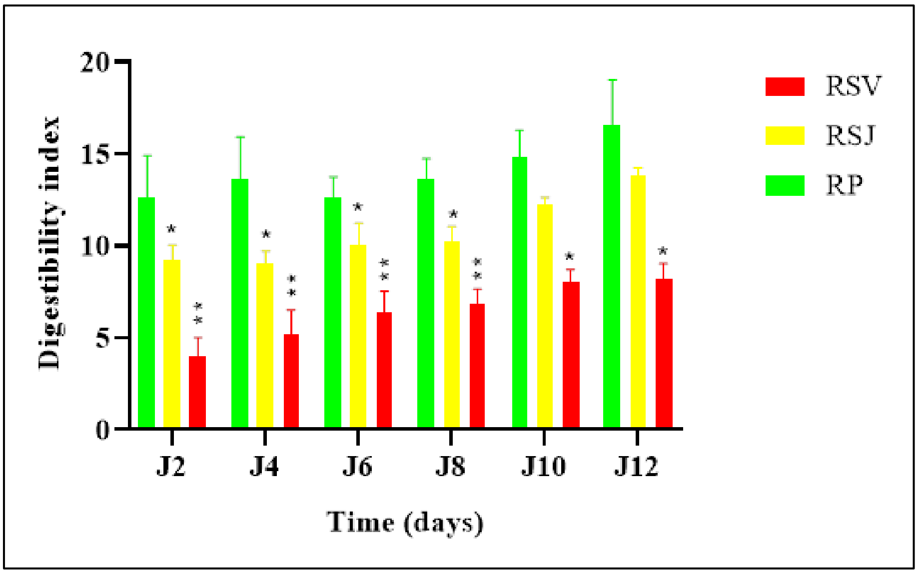

Figure 3 Variation in the digestibility index of rats over the course of the experiment

3.3.4. Biometrics of the regulatory organs of nutrition

The average values for the relative weights of each organ are recorded in Table 6. Feeding rats different diets did not result in any significant changes (p>0.05) between the relative weights of animals fed the fish-based diet compared to those fed the yellow soybean and green soybean diets.

Table 6 Relative weights of the nutritional regulatory organs of rats fed different diets

Parameters	RP	RSJ	RSV
Live (%)	3.50 ± 0.12	3.21±0.11^{ns}	3.32±0.07^{ns}
Sidney (%)	0.68 ± 0,02	0.57±0.1^{ns}	0.60±0.01^{ns}
Hart (%)	0.52 ± 0.03	0.44±0.01^{ns}	0.48±0.02^{ns}
Spleen (%)	0.31 ± 0.01	0.26±0.01^{ns}	0.29±0.02^{ns}
ileum (%)	0.42±0.02	0.38±0.1^{ns}	0.38±0.01^{ns}

Values are means ± standard errors, with each batch comprising 5 animals (n=5/group). The comparison was performed using one-way analysis of variance (ANOVA 1) followed by Tukey's test (ANOVA 1); ns: not significant; RP: Fish-based diet; RSJ: Yellow soybean-based diet; RSV: Green soybean-based diet; MSTI: Ingested total dry matter; CEA: coefficient of feed efficiency

4. Discussion

The flours of two varieties of soybeans (*Glycine max* and *Glycine hispida*) commonly used in the dietary practices of the people of Côte d'Ivoire were studied in order to assess their best nutritional use. Chemical analysis of the flour from these two soybean varieties revealed the presence of organic nutrients (carbohydrates, lipids, and proteins), minerals (calcium, potassium, iron, and magnesium), dietary fiber, and moisture content. The water content obtained (7.25% for yellow soybeans) and (8.85% for green soybeans) is similar to that reported by [17; 18] after analyzing *Ricin dendron hodologic* almond flour and soybeans, respectively. This low moisture content could be explained by the fact that harvesting takes place when the pods containing the seeds are dry. Indeed, the water content in a given food product can be affected by either climatic conditions or the drying and storage methods used. The low water content in the seeds of both soybean varieties is an advantage in terms of their shelf life, as the risk of deterioration is limited by chemical reactions [19] and even a reduction in the proliferation of microorganisms. Regarding the protein content of the two soybean varieties (yellow soybeans and green soybeans), analyses showed respective levels of 32.25% and 24.55%. This protein content in yellow soybeans is similar to that found by [20] but different from that in green soybeans. In view of these different contents, it is clear from these values that soybean flour is an important plant source of protein and could therefore be used to solve problems of protein-energy malnutrition. In addition, according to the literature, proteins are the major source of amino acids and play an important role in organoleptic properties [21]. In terms of carbohydrate content, yellow soybeans contain 21.52% and green soybeans contain 48.15%. The carbohydrate content of green soybeans is similar to that of *Blighia sapida* arils, which is around 43% according to [22]. It should be noted that the presence of carbohydrates in a food gives it an energetic character [23]. The lipid content for yellow soybeans and green soybeans is 15.01% and 1.32%, respectively. Yellow soybean flour is richer in lipids than green soybean flour. This low lipid content in green soybeans is similar to that found in *Borassus aethiopum* almonds (2.4%) [24] and Cycas fruits (2.39%) [25]. In fact, lipids contribute greatly to the absorption of fat-soluble vitamins and therefore remain important for meals. This is the case with certain oils that contain high levels of polyunsaturated fatty acids, which are beneficial for controlling cholesterol levels and protecting the body against cardiovascular disease [26]. In addition to these organic nutrients, yellow soybean flour and green soybean flour also contain dietary fiber, with respective contents of 14.10% and 17.05%. These different contents vary slightly and are similar to that of *Borassus aethiopum* almonds, which is 13.05% [24]. Indeed, the presence of fiber in food is essential because it promotes digestive health by improving bowel regularity and helping to reduce blood cholesterol levels. They may also have positive implications for satiety and weight management [27]. As for minerals, they are present in yellow soybean and green soybean meal, such as calcium, potassium, iron, and magnesium. The nutritional content of yellow soybeans is calcium (224.32 mg), potassium (442.31 mg), iron (13.06 mg), magnesium (192.47 mg), and for green soybeans, calcium (13.65 mg), potassium (362 mg), iron (6.45 mg), and magnesium (192.47 mg). The significant presence of these minerals in yellow and green soybeans is an advantage in terms of the nutritional value of these foods, as minerals play an important role in bone mineralization [28], the production of thyroid hormones and hemoglobin, and the development and maintenance of the nervous, muscular, and immune systems [29]. In addition, various nutritional parameters taking into account weight gain, coefficient of feed efficiency, digestibility, and biometrics of regulatory organs were evaluated. Thus, for the nutritional values of yellow soybeans and green soybeans, the results obtained and expressed by ingested total dry matter (MSTI) reveal that there is no significant difference ($p>0.05$) in rats fed diets based on yellow soybeans and green soybeans compared to those fed a fish-based diet. These results show that the rats enjoyed the different diets formulated and fed to them throughout the experimental period. This is reflected in the health status and weight gain observed in rats fed these different diets, demonstrating the quality of the intrinsic nutritional composition of these formulations. According to [30], foods rich in high-quality protein, such as soy, promote increased protein synthesis, which is essential for muscle development and weight gain. With regard to the coefficient of feed efficiency (CEA), no significant differences were observed between rats fed the different diets. These results are similar to those observed by [31; 32] in monogastric animals fed diets based on cassava flour, soybean meal, and local chicken varieties, broiler chickens, and hybrids derived from their crossbreeding. In terms of digestibility, the fish-based diet has the best index with a rate of 17%, confirming the benefits of a formulation with several ingredients. In terms of soybean-based diets, yellow soybean stands out for its superior digestibility compared to green soybean. This result corroborates those obtained by [33], who clearly demonstrated that yellow soybeans are more digestible than green soybeans due to their higher soluble protein content. Furthermore, [34] showed that this digestibility can be affected by the processing method, with soaking and cooking significantly improving the assimilation of nutrients from these foods. It should be noted that all these results show that the digestibility index of formulated feeds varies according to the composition of the rations tested. Finally, the results relating to the relative weights of the organs revealed similar values for the liver, kidneys, heart, spleen, and ileum of rats on different diets. As a result, these diets had no effect on the weight of these organs. These results corroborate those of [35 ;36], who also observed no change in the weight of these nutrition-regulating organs in rats fed different diets based on maggot flour and legumes. In light of these various findings, soy consumption could be promoted due to its richness in nutrients that are essential for the proper functioning of the body.

5. Conclusion

This study demonstrated that yellow soybean (*Glycine max*) and green soybean (*Glycine hispida*) flours provide valuable nutrients, including proteins, lipids, carbohydrates, fiber, and essential minerals. Both varieties supported growth performance, feed utilization, and organ health in growing Wistar rats, with no adverse effects observed. Although yellow soybean showed higher protein and lipid contents and slightly better digestibility compared to green soybean, both varieties proved to be suitable dietary alternatives to fishmeal. These findings suggest that soybean flours can serve as safe, nutrient-rich food sources and may contribute to improved dietary practices and efforts to combat malnutrition.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

Ethical approval was obtained.

References

[1] Ekombe ME, Maboso MJL, TROIS PE, Ipolo DM, Bendo MF, Dathi GJC and Yebele LV. Problématique de la prise en charge de la malnutrition aigüe sévère chez les enfants de 0 à 5 ans dans la zone de santé de Karawa. International Journal of Progressive Sciences and Technologies, 2023 ;41(2): 19-28.

[2] Fanzo J, Bellows AL, Spiker ML, Thorne-Lyman AL and Bloem MW. (2021). The importance of food systems and the environment for nutrition. The American Journal of Clinical Nutrition, 2021 ;113(1) : 7-16. https://doi.org/10.1093/ajcn/nqaa313.

[3] Ogbemudia RE, Nnadozie BC. and Anuge B. Mineral and proximate composition of soya bean. Asian Journal of Physical and Chemical Sciences, 2018;4(3), 1-6.

[4] Knez M, Ranić M and Gurinović M. (2023). Underutilized plants increase biodiversity, improve food and nutrition security, reduce malnutrition, and enhance human health and well-being. Let's put them back on the plate! Nutrition Reviews, 2023 ;82(8), 1111-1124. https://doi.org/10.1093/nutrit/nuad103.

[5] Mishra R, Tripathi MK, Sikarwar RS, Singh Y and Tripathi N. Soybean (*Glycine max* L. Merrill): A multipurpose legume shaping our world. Plant Cell Biotechnology and Molecular Biology, 2024 ;25(3-4), 17-37. https://doi.org/10.58257/PCBMB2024/25.03-4/823-4843

[6] Ali W, Ahmad MM, Iftikhar F, Qureshi M and Ceyhan A. (2020). Nutritive potentials of soybean and its significance for human health and animal production: A review. Eurasian Journal of Food Science and Technology, 2020 ;4(1), 41–53.

[7] https://dergipark.org.tr/en/download/article-file/1273470

[8] Rizzo G and Baroni L. Soy, soy foods and their role in vegetarian diets. Nutrients, 2018 ;10(1), 43. https://doi.org/10.3390/nu10010043.

[9] Parrini S. Aquilani C, Pugliese C, Bozzi R and Sirtori F. Soybean replacement by alternative protein sources in pig nutrition and its effect on meat quality. Animals, 2023;13(3), 494.

[10] Singh S, Saini PK, Bhati J, Kumar D, Shukla S and Yadav S. Management of nutrients in soybean (*Glycine max*) crops: A review. Journal of Advances in Biology and Biotechnology, 2024;27(10), 820-833.

[11] Fekadu G, Hussein M and Getinet A. Genotype x environment interactions and stability of soybean for grain yield and nutrition quality. African Crop Science Journal, 2009 ;17 (2) : 87-99.

[12] Qiu L and Chang RZ. Le soja : botanique, production et utilisations, 2010 ;1-23.

[13] Dallal GE and Wang M. Nutritional evaluation of *Glycine hispida*: A comparative study with *Glycine max*. Journal of Food Science and Technology, 2008 ;55(2): 467-475.

[14] OCDE. Série sur les principes de bonnes pratiques de laboratoire et vérification du respect de ces principes. ENV/MC/CHEM; 1998 ;17 : 22-23.

[15] AOAC. Officials methods of analysis 15th Ed William. Horwith edr Washingston DC, 1980.

[16] AOAC. Officinal technology of analysis. Arlington, VA: Association of officinal analytique chemists, 1998;16(2): 23-34.

[17] Kouakou YMA. Evaluation de la performance nutritionnelle des amandes de Akpi (Ricinodendron heudelotii) chez le rat (Rattus norvegicus) de souche Wistar en croissance. Mémoire de Mastar de nutrition-santé-comportement spécialité : Nutrition-Pharmacologie-Toxicologie, UFR Biosciences, Université Félix HOUPHOUET-BOIGNY, Abidjan, Côte d'Ivoire, 2023 ;51p

[18] Saki SJ, Mosso K, Sea TB and Diopoh KJ. Détermination de quelques composants essentiels d'amandes de akpi (Ricinodendron heudelotii) en Côte d'Ivoire. Agronomie Africaine, 2005 ;17(2) : 137-142.

[19] Ali MA, Yunus M, Salam A and Huq M. Variability in moisture content and storage stability of soybean varieties. Journal of Food Science and Technology, 2016;53(2), 456-462.

[20] FAO. Maize in human nutrition. FAO Food and Nutrition Series, No. 25, 1992. Rome: FAO. Disponible en ligne : http://www.fao.org

[21] Karaboneye F. Characterization of the Symbiotic Efficiency of Highly Promiscuous African Soybean Lines. Master's Thesis in Biology. Université de Laval, Quebec, Canada, 2013;123 pp.

[22] Akinhanmi TF, Atsie VN, Senior L and Akintokum PO. Chemical composition and physicochimical properties of cashew nut (Anacardium occidentale) shell liquid. Journal of agricultural food and environnement sciences, 2008 ;2 : 1-2.

[23] Ouattara H, Niamké B, Dally T and Katty CS. Nutritional composition studies of sum dried Blighia sapida (K. koenig) aril from côte d'ivoire. Journal of applied Bioscience, 2010 ;32: 1989–1994.

[24] Remesy C. L'alimentation de demain. De l'alimentation santé à l'agriculture durable. INRA- U3M/ Theix. 2001 ;137p.

[25] Kabiru JU, Bello MA, Badaru M, Sirajo M, Lawal GH and Nasiru AS. Nutritional and Antinutritional Profile of Borassus aethiopum Mart (African Palmyra Palm) Shoots. International Journal of Sciences. Basic and Applied Research, 2015 ; 1-11.

[26] Ibrahim SA, Razanamparany L and Olivier G. Les fruits de Cycas : une ressource alimentaire inestimable pour les Comores. 2ème Journées Scientifiques, 2012 ; QualiREG, St. Gilles les Hauts, La Réunion.

[27] Azibuo JY, Akromah RA, Dapaah HK and Safo K.. Evaluation of nutritional quality of groundnut Arachis hypogaea from Ghana. African Journal of Food Agriculture Nutritional and Development, 2008 ;8 (2):1684-1694.

[28] Nkondjock A, Njike V and Mozaffarian D. The effect of Irvingia gabonensis seeds on dietary fiber intake and weight loss in overweight individuals: a randomized controlled trial. Journal of Nutrition, 2019 ;9(3) : 345-352.

[29] Dansou P, Akplogan B, Avalla C and Mer W. Apport énergétique et calcique dans l'alimentation des aldolescences de la Ville de Porto- novo (BENIN). Médecine d'Afrique noire, 2000 ;47 (8/9).

[30] Aremu MO, Olaofe.O and Akintayo TE. A comparative study on the chemical and amino acid composition of some Nigerian under ultized legume flours. Pakistan Journal of Nutrition, 2006 ;5, 34-38.

[31] Smith J, Lee R and Carter P. Protein sources and their impact on animal growth: A review. Animal Nutrition Science, 2021 ;10(2) : 345-358.

[32] Zannou TV. Stratégies d'amélioration des farines à base de manioc et de soja de haute densité énergétique par incorporation de farine de maïs germe. Thèse 3è Cycle, Université de Cocody, Abidjan (Côte d'Ivoire), 2005 ;116 p.

[33] Beugré GAM. Etude comparée des performances zootchniques et des qualités organoleptiques des variétés de poulet local, de poulet de chair et des hybrids issus de leur croissement génétique. Thèse de Doctorat Université Abobo-Adjamé, Abidjan (Côte d'Ivoire), 2008 ;130 p.

[34] Diallo SA, Traoré MK and Keita BL. Comparative study of the digestibility of white soybean, green soybean, and cowpea proteins in rats. International Journal of Food and Nutrition Sciences, 2019 ;22(4) : 57-68.

[35] Yao ND, Traoré KB and Soro AT. Influence of soaking and cooking methods on nutrient absorption in soybean-based diets. Food Processing and Nutrition Science, 2016;18(3): 49-63.

[36] Bouaffou KGM. Etude de la valeur nutritionnelle de la farine d'asticots sèches chez les rats en croissance. Revue Ivoirinnee des Sciences et Tchnologie, 2008 ;12: 215-222.

[37] Smith DL, Brown PJ and Harris C. Cardiovascular effects of legume-based diets in rodent models. International Journal of Experimental Biology, 2018;29(2): 102-110.