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A Selection of Phaseolus Vulgaris Bean Varieties to Explore Their Nutritional Quality from the Dawn of Creation to the Science and Technology of the Modern World

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Abstract: *The Malagasy Phaseolus vulgaris L varieties analyzed in this study showed the presence of high nutritional elements, particularly protein levels of 20.3899%; 21.3130%; 20.6173%; 23.0134%; 21. 7245%; 21.3049% respectively for the six varieties 55(B), RI 5-2, CAL 98, Ran'omby 1, RI 5-3, Ran'omby 4, as well as carbohydrate contents ranging from 57.4657% for Ran'omby 1 to 65.1171% DM for CAL 98. The presence of essential mineral elements for human nutrition (iron, zinc, magnesium, calcium, potassium, sodium, phosphorus...) and phytochemical families reveal its virtues as a food. This means that Phaseolus vulgaris L is a complete human food.*

Keywords: *Phaseolus vulgaris L; nutritional; protein; lipid; carbohydrate; mineral elements*

I. Introduction

In a world marked by constantly evolving science and technology, the idea of divine action has become problematic. On the third day, the earth was created and the Master of the Universe commanded it to produce seed plants (Genesis 1:11). Everything was ready, and the Master of the Universe, in His own image, created man and ordered him to subdue the earth. This Creator gave to man, according to Genesis 1:29, every seed-bearing herb on the face of the whole earth as food. No mention of testing or analysis, this Creator says He found good in what was created. May Science elucidate this almost gratuitous assertion? Do this transcendence and the fine physicochemical analyses of science intersect?

II. Research Methods

2.1 History of the Seeds

To this day, man feeds on these seed-bearing herbs, herbaceous plants with seeds. Different versions of the Bible speak of them. Modern translations such as New International Version, New Living Version, Amplified Bible, and Christian Standard Bible translate these plant materials as "plant". Classic Translations such as King James Bible, and New King James Version say "herb" and Peshitta Holy Bible Translated Translations from Aramaic write "grass".

What do specialists and botanists have to say? What exactly is the situation?

Etymologically from the ancient Greek βοτανική, botanikê, botany means the science of herbs. Botany, therefore, includes not only the science of describing, classifying, and identifying plant species but also that part of plant anatomy and physiology known as "plant physics".

If Aristotle is the founder of botany (circa 347 BC), Daniel Jeanmonod, a specialist in Mediterranean flora, writes in "Conservatoire et Jardin Botaniques de Génève" that the father of botany is the philosopher Theophrasus (350-285 BC), who began classifying plants into 4 groups: herbs, sub-shrubs, shrubs, and trees. Would Theophrasus, by name, have felt it his duty to translate the sentences of the process by which these plants were created? Dioscorides

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(1 century AD), a Greek military physician, then played an important role by describing 600 medicinal plants. Then Ibn Sina (also known as Avicenna, 980-1037), an Arab physician, wrote the "Canon of Medicine" with the medicinal properties of 758 plants, a work that was used in medicine for centuries, in both East and West. Following in the footsteps of many other important figures, we should mention Johannes Bauhin (1541-1612), based in Geneva and also nicknamed the "father of botany", who wrote the universal history of plants (Historia plantarum universalis) in which he described 5,000 species, mostly European. Finally, Carl von Linné (1707-1778), the father of taxonomy, established a 2-name system (binomial name) for naming plants and animals.

The seeds chosen for this study are known under the binomial name *Phaseolus vulgaris* for their worldwide distribution.

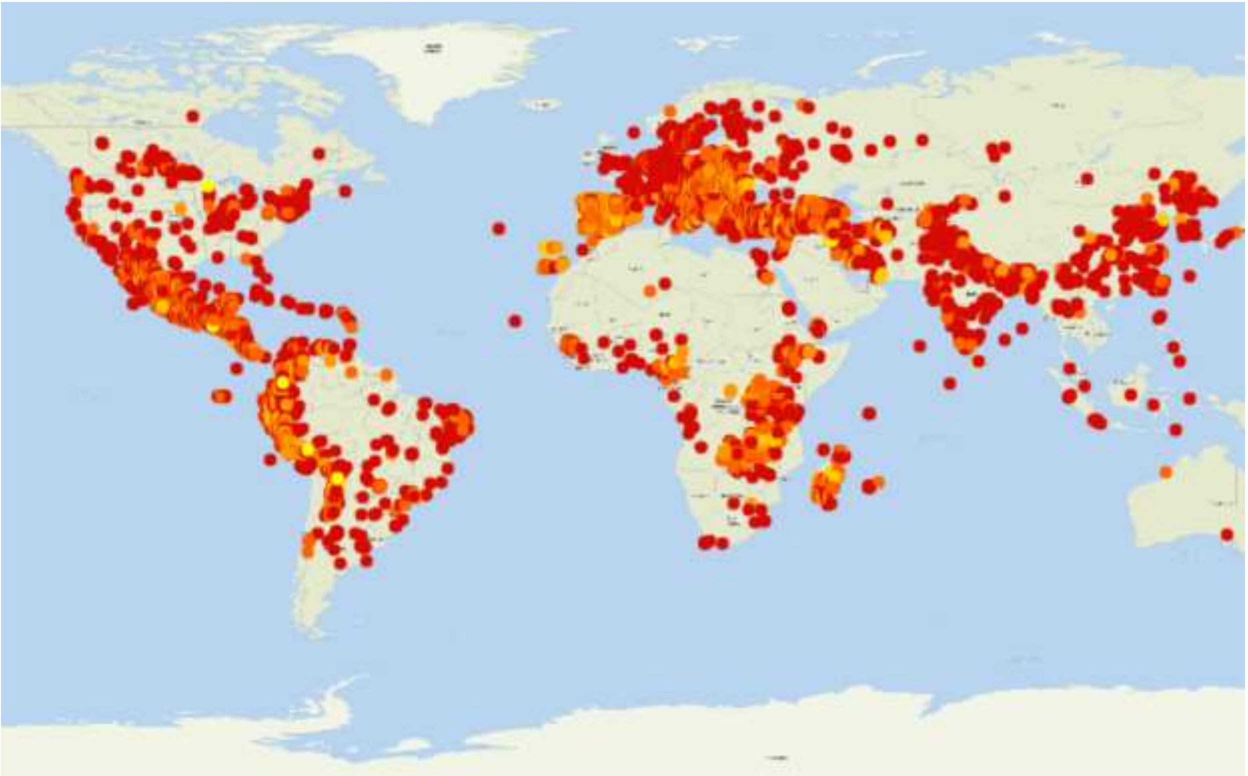

Figure 1. *Worldwide presence of Phaseolus vulgaris from 1785 to 2023*
Source: GBIF, (Global Biodiversity Information Facility)

For centuries, this map shows that *Phaseolus vulgaris* has been present and cultivated on every continent except the Arctic, as confirmed by Paul Gepts in 1998 in his article entitled "Origin and evolution of common bean: Past events and recent trends".

2.2 The Bean's Place in the World

The very first representatives of the *Homo genus* - *Homo habilis* appeared in Africa 2.4 (or perhaps 2.8) million years ago, and for hundreds of thousands of years consumed mainly sweet fruits, seeds, and plants or parts of plants (**Birlouez, 2020**).

In 2020, just under 400,000 ½ tonnes of canned beans were traded worldwide, representing a growth of 10% over the five-year average.

Kenya ranks 3rd among world exporters, with France as its main customer, accounting for 60% of its sales volumes in 2020. France exported more canned beans to its European neighbors (+34% in 2020 vs. an average of 15-19). (**Orhan et *al.*, 2020**)

2.3 Bean Varieties Studied

Beans play an important role in man's socio-economic life and everything that concerns him. The study undertaken focused on several varieties of beans growing in certain districts and provinces of Madagascar, whose binomial name is *Phaseolus vulgaris* of the Fabaceae family, in view of its history and place in the world. Beans are the most widely consumed legume in Madagascar, around 45 g/person/day (**FO.FI.FA, 2010**).

Six (6) bean varieties were used in this study, with the sampling sites listed in the table below. Four bean-growing provinces were chosen to diversify the sampling areas. They are recognized by their shape and color, translated by their Malagasy vernacular names.

Table1 : Bean sampling sites

Sample	*Mena botakely* 55 (B) 	*Ranjonomby* RI 5-2 	*Vangamena* Cal 98 
District **Region** **Province**	Ambohimahasoa Haute Matsiatra Fianarantsoa	Ambohimahasoa Haute Matsiatra Fianarantsoa	Betafo Vakinankaratra Antananarivo
Sample	FOFIFA *Ran'omby* 1 (DRK 64) 	*Ranjon'omby* RI 5-3 	FOFIFA *Ran'omby* 4 (DRKF) 
District **Region** **Province**	Miandrivazo Menabe Toliara	Marovoay Boeny Mahajanga	Marovoay Boeny Mahajanga

Pinto beans, black, white, or in various colors all belong to the *Phaseolus vulgaris* L root, one of the world's most widespread crops (**FAO, 2016**). Aside from cereals, legumes are considered the second most important source of food for humans and play a very important role in the diet, especially for developing countries (**Du and *al.*, 2014**).

2.4 Determination of Nutritional Values

Research into seed moisture (**Multon, 1991**) according to French Standard NF V 04 - 282, crude ash content according to French Standard NF V 04-208, and determination of macronutrient content and energy value such as fat content enabled us to better characterize these six *Phaseolus vulgaris* varieties. The hexane percolation method (**Wolff, 1991**) on Soxlhet was used to determine fat content, while the Kjeldahl method (**AFNOR, 1993**) was used to determine total protein content and the amino acids they contain, using the Mossé method (1990). Concentrated sulfuric acid and sodium hydroxide were used as reagents. Finally, carbohydrate content was determined according to the following equation.

a. Carbohydrates Content

The total carbohydrate content of the sample is deduced from the difference between the dry extract content and the sum of the protein, lipid, and crude ash contents (**Adrian and *al*., 1995**) according to the formula:

TC % = 100 – (P % + LC % + CA %)

- TC%: total carbohydrate content in g per 100 g of dry matter
- P%: protein content in g per 100 g of dry matter
- LC%: lipid content in g per 100 g of dry matter
- CA%: crude ash content in g per l00 g of dry matter.

b. Energy Value

The overall energy value is the energy released by the combustion of macronutrients: proteins, carbohydrates, and lipids contained in the diet, taking into account their Atwater coefficients: 4 Kcal, 4 Kcal, and 9 Kcal respectively (**Greenfield and Southgate, 1992**). Calculation method the energy value is expressed in kilocalories (Kcal) and calculated using the relationship:

$$E\ (Kcal) = (9\times\mathbf{L}) + (4\times\mathbf{P}) + (4\times\mathbf{C})$$

With:

- **L**: Lipid content in g per 100 g of dry matter
- **P**: Protein content in g per 100 g of dry matter
- **C**: Carbohydrates content in g per 100 g of dry matter

2.5 Analyse physique du *Phaseolus vulgaris l.* par la fluorescence X

The analysis of mineral elements using X-ray fluorescence spectroscopy was carried out at the INSTN (Institut National de Science et Technique Nucléaire) laboratory. The SPECTRO EXPOS energy-dispersive X-ray fluorescence spectrometer consists of an X-ray tube with a palladium (Pd) anode, producing a 50-watt primary beam, and a target changer comprising a Bragg polarizer and secondary molybdenum and cobalt sources.

2.6 Phytochemical screening

The Phytochemical Screening method was used to identify families of chemical compounds in beans.

III. Results and Discussion

3.1 Nutritional Values of Beans

Table 2 below shows the nutritional values of the beans used in this study. The total amount of carbohydrates is deduced by the difference from the other nutrients. The total carbohydrate content (G%), expressed in g per 100g MB, is obtained by the following calculation:

$$\%Lipids + \%Proteins + \%Humidity + \%Ash + \%Carbohydrates = 100$$

Table 2: Nutritional values obtained from beans

Samples	55(B)	RI 5-2	CAL 98	Ran'omby 1	RI 5-3	Ran'omby 4	Average
H (%)	9.8622	10.9292	9.1477	13.4338	11.1717	9.8319	10.7294
DM (%	90.1378	89.0708	90.8523	86.5662	88.8283	90.1681	89.2705
Ash (%)	5.3299	4.0890	3.2775	3.5777	3.3828	3.3630	3.8366
Proteins (%)	20.3899	21.3130	20.6173	23.0134	21.7245	21.3049	21.3938

Lipids (%)	2.3823	3.3440	1.8404	2.5094	2.5057	2.1839	2.4609
Carbohydrates (%)	62.0357	60.3248	65.1171	57.4657	61.2153	63.3163	61.5779
EV (kcal)	351.1431	356.647	359.5012	344.5010	354.3105	358.1399	354.040

H (%): Humidity DM: Dry Material EV: Energy Value

According to these analytical results, the water content of our samples in this study varies from 9.14% to 13.43%, while their average content is equal to 10.72%. Compared with the results found by other authors, this is similar to the average water content of *Phaseolus* beans (white bean, dark red bean, dark red bean, and kidney bean) found by other authors, which is equal to 10.59% (**Rasoanandrasana, 2016**).

Next, variety 55(B) has the highest crude ash content (5.32%), while CAL 98 has the lowest (3.27%). The average crude ash content is thus 3.83%. The latter is low in crude ash compared with Andriamasinandraina's (2016) reference value of 4.23%. This could be explained by the composition of the soil where this bean was grown (**Deosthale and Belavady, 1978**).

3.2 Proteins

From a nutritional point of view, the protein values of our samples "55(B), RI 5-2, CAL 98, *Ran'omby* 1, RI 5-3, *Ran'omby* 4" are equal to 20.3899%; 21.3130%; 20.6173%; 23.0134%; 21.7245%; 21.3049% respectively. However, Rasoanandrasana found 24.85% "*Tsaramaso vandamena*"; 22.84% "*Tsaramaso mena*" and 23.84% (ODR); 23.00% (RI 5-5); 23.45% (MN 12 651-9); 20.84% (MN 9) respectively. Indeed, the *Ran'omby* 1 variety in our samples contains the highest protein content (23.0134%), which is comparable to the results found by Rasoanandrasana. In addition, seed proteins contain almost all the essential amino acids. All the red beans had higher protein levels than the other varieties and colors, except for variety 55(B), CAL 98, 20.3899%, and 20.6173%. This could mean that protein levels depend on bean variety and color.

3.3 Amino acids

Table 3 shows the results of the analysis of the amino acids present in the samples.

Table 3. Amino acid levels expressed in g per 100g DM (dry material) and in g per 100g protein after analysis

Amino acids	Amino acid levels expressed in g per 100g DM						Amino acid levels, expressed in g per 100g of proteins					
Samples	55(B)	RI 5-2	CAL 98	*Ran' omby*	RI 5-3	*Ran' omby*	55(B)	RI 5-2	CAL 98	*Ran' omby*	RI 5-3	*Ran' omby* 4
Gly	0.71	0.78	0.79	0.87	0.85	0.74	3.97	3.76	3.80	3.66	3.70	3.89
Ala	0.84	0.91	0.92	1.00	0.98	0.87	4.70	4.39	4.43	4.19	4.25	4.57
Val	0.92	1.04	1.05	1.17	1.14	0.96	5.15	5.01	5.02	4.91	4.94	5.04
Leu	1.59	1.79	1.80	2.02	1.96	1.67	8.90	8.63	8.66	8.47	8.51	8.78
Ile	0.77	0.89	0.90	1.02	0.99	0.82	4.31	4.29	4.31	4.27	4.28	4.31
Ser	1.05	1.23	1.24	1.43	1.38	1.12	5.87	5.93	5.95	5.99	5.98	5.89
Thr	0.89	0.97	0.98	1.06	1.04	0.92	4.98	4.68	4.69	4.46	4.52	4.83
Tyr+Phe	1.72	1.98	1.99	2.27	2.20	1.82	9.63	9.55	9.58	9.53	9.55	9.57
Pro	0.71	0.78	0.79	0.86	0.84	0.74	3.97	3.76	3.78	3.60	3.65	3.89
Trp	-	-	-	-	-	-	-	-	-	-	-	-
Met	0.23	0.25	0.26	0.29	0.28	0.24	1.28	1.20	1.25	1.20	1.21	1.26
Cys	0.26	0.27	0.28	0.29	0.28	0.27	1.45	1.30	1.33	1.21	1.24	1.42

Lys	1.30	1.46	1.47	1.63	1.59	1.36	7.27	7.04	7.04	6.85	6.90	7.15
His	0.47	0.55	0.56	0.64	0.62	0.50	2.63	2.65	2.69	2.70	2.69	2.63
Arg	0.78	1.10	1.12	1.46	1.36	0.91	4.36	5.30	5.36	6.10	5.92	4.78
Asp	2.34	2.66	2.67	3.00	2.91	2.47	13.10	12.83	12.83	12.58	12.64	12.99
Glu	2.83	3.29	3.31	3.78	3.65	3.01	15.84	15.87	15.88	15.86	15.86	15.83
Met+cys	0.28	0.29	0.29	0.30	0.30	0.29	1.56	1.39	1.41	1.26	1.30	1.52

The percentage of essential amino acids in relation to total amino acids is shown in Table 4 below.

Table 4. Ratio of essential amino acids to total amino acids in the laboratory

Sample	**55(B)**	**RI 5-2**	**CAL 98**	**Ran'omby 1**	**RI 5-3**	**Ran'omby 4**
Amino acids (%)	44.88	44.31	46.68	47.09	47.01	44.57

The seed proteins of the beans studied contain almost all the amino acids shown in Table 3. It was noted that tryptophan is not present in the seeds, while they are rich in Lys. But they are low in methionine and cysteine, found by calculating the chemical index. The latter are therefore sulfur-containing amino acids, considered to be the primary limiting amino acids. The ratio of essential amino acids to total amino acids ranged from 44.31% (RI 5-2) to 47.01% (*Ran'omby* 1), which is higher than the reference value for a protein of good biological value (32%). These results coincide with those reported by other authors (**Rasoanandrasana, 2016; Randrianasolo, 2016; Andriamasinandraina, 2012**). To rectify this low content, supplementation with other foods rich in sulfur-containing amino acids but low in lysine, such as cereals, is necessary (**Cheftel, 1985**). The mixture may have a higher-quality amino acid profile (**Cheftel and *al.*, 1985**).

However, compared to the needs of infants, the sulfur amino acids (Methionine and Cysteine) in seed proteins are deficient with low chemical indices and thus constitute the limiting factors of proteins.

The essential amino acid content of seed proteins is high compared with the requirements of children over 2 years and adults. The proteins in the bean samples studied can therefore be used without supplementation.

3.4 Fat Materials

Dry bean seed fat values vary from species to species, from 1.83% (CAL 98) to 3.34% (RI 5-2). These can be compared with those reported in the literature for common beans, which range from 1.12% to 1.68% (**Rasoanandrasana, 2016**). Beans are considered low-fat legumes (**FAO, 2016**).

3.5 Carbohydrates

With regard to carbohydrate content, the results of Rasoanandrasana (2016) on samples of "*Phaseolus vulgaris* L." are high, ranging from 70.00% to 73.99%, compared with our samples analyzed in this study, which vary from 57.4657% (*Ran'omby* 1) to 65.1171% MS (CAL 98). On the other hand, these results could be compared with the results found on protein legumes, the same species as our samples "*Phaseolus vulgaris* L", by Andriamasindraina (2012), 58.32% "*Tsaramaso vandamena*"; 59.79% "*Tsaramaso mena*" and 58.73% "*Tsaramaso fotsy*", and by Randrianasolo (2013) which is equal to 58.82% for the sample "*Tsaramaso vanda mena*". Bean seed carbohydrates are mainly concentrated in starch, which accounts for 50% to 80% of total legume carbohydrates (**FAO, 2016**). The beans in this study could be enriched with carbohydrates.

The beans analyzed in this study are classified as protein crops because of their high protein and carbohydrate content. They give us high energy values ranging from 344.5010 Kcal (*Ran'omby* 1) to 359.5012 Kcal (CAL 98).

3.6 Mineral elements

Table 5 shows the results of mineral element analyses carried out on beans:

According to the results of analysis by X-ray fluorescence spectroscopy at the INSTN (Institut National de Science et Technique Nucléaire) laboratory, the "*Mena botakely* (55(B))" variety is the richest in mineral elements, followed by the "*Ranjonomby* (RI 5-2)", "DRK 64", "FOFIFA *Ran'omby* 4 (DRKF)", "*Ranjonomby* RI 5-3" and finally "*Vangamena* CAL 98". For these six varieties, the mineral content is around 3g per 100g of dry matter. Potassium K is the most dominant element, followed by phosphorus P, magnesium Mg, and calcium Ca. On the other hand, they are all low in sodium Na. The literature confirms that legumes are rich in iron Fe, potassium K, magnesium Mg, and zinc Zn. While they are low in sodium Na (**FAO, 2016**).

This difference may be due either to the influence of genetic factors, in particular grain hardness, size, and husk content, or to pedological factors (soil type, humus richness, availability of minerals in the soil where they are grown) or agronomic factors (type of fertilizer, sowing density, previous crops) or climatic factors (sunshine, humidity).

3.7. Phytochemical screening

The results of the phytochemical screening of bean seeds are presented in Table 6.

Table 5. Mineral elements obtained by TXRF in *Phaseolus Vulgaris L.*

Elements	**Unit**	***Mena botakely* 55(B)**	***Ranjonomby* RI 5-2**	***Vangamena* CAL 98**	**DRK 64 or FOFIFA *Ran'omby-1***	***Ranjonomby* RI 5-3**	**FOFIFA *Ran'omby* 4 (DRKF)**
Naturium (Na)	mg/kg	< 100	< 100	< 100	< 100	< 100	< 100
Magnesium (Mg)	mg/kg	761.50 ± 68.54	750.00 ± 67.50	654.50 ± 58.91	657 ± 59	609 ± 55	623.50 ± 56.12
Aluminum (Al)	mg/kg	496.65 ± 39.73	34.50 ± 2.42	< 20	< 20	< 20	39.05 ± 2.73
Silicon (Si)	mg/kg	1697.50 ±	217.75 ± 17.42	120.85 ± 9.67	175.80 ± 12.31	209.45 ± 16.76	269 ± 22
Phosphorus (P)	mg/kg	5189 ± 467	5793 ± 521	4487.50 ± 403.88	5879.50 ± 529.16	4760.50 ± 428.45	4801 ± 432
Sulfur (S)	mg/kg	2211 ± 199	2338 ± 187	2036.50 ± 162.92	2761.50 ± 220.92	2080 ± 166	2100 ± 168
Chlorine (Cl)	mg/kg	457.65 ± 36.61	496.10 ± 39.69	260.40 ± 18.23	325.20 ± 22.76	334.50 ± 23.42	349.75 ± 24.48
Potassium (K)	**%**	**1.77 ± 0.12**	**1.86 ± 0.15**	**1.31 ± 0.10**	**1.67 ± 0.13**	**1.41 ± 0.11**	**1.42 ± 0.11**
Calcium (Ca)	mg/kg	2138 ± 171	677 ± 54	551.65 ± 44.13	394.60 ± 31.57	560.95 ± 44.88	708.90 ± 56.71
Titanium (Ti)	mg/kg	77.85 ± 6.23	6.70 ± 0.47	3.60 ± 0.25	6.20 ± 0.43	12.35 ± 0.86	7.75 ± 0.54
Chromium (Cr)	mg/kg	2.45 ± 0.17	0.70 ± 0.05	1.35 ± 0.09	2.01 ± 0.14	1.80 ± 0.13	1.50 ± 0.11
Manganese (Mn)	mg/kg	35.70 ± 2.86	36.15 ± 2.89	34.25 ± 2.74	28.10 ± 1.97	32.50 ± 2.28	32.80 ± 2.30
Iron (Fe)	mg/kg	484.55 ± 38.76	130.80 ± 11.77	93.20 ± 7.46	115.10 ± 9.21	138.25 ± 11.06	133.30 ± 10.66
Cobalt (Co)	mg/kg	< 3	< 3	< 3.00	< 3	< 3	< 3
Nickel (Ni)	mg/kg	2.80 ± 0.20	2.45 ± 0.17	2.05 ± 0.14	2.30 ± 0.16	1.75 ± 0.12	1.90 ± 0.13
Copper (Cu)	mg/kg	13.05 ± 1.04	12.95 ± 1.04	11.00 ± 0.77	13.30 ± 0.93	13.40 ± 0.94	11.00 ± 0.77
Zinc (Zn)	mg/kg	37.50 ± 3.38	39.20 ± 3.14	34.70 ± 2.78	45.80 ± 3.66	35.90 ± 2.87	35.60 ± 2.85
Arsenic (As)	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Selenium (Se)	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Bromine (Br)	mg/kg	0.30 ± 0.02	0.40 ± 0.03	< 0.1	0.20 ± 0.01	0.30 ± 0.02	0.20 ± 0.01
Rubidium (Rb)	mg/kg	81.25 ± 5.69	83.40 ± 6.67	56.60 ± 4.53	76.80 ± 6.14	62.00 ± 4.96	63.35 ± 5.07
Strontium (Sr)	mg/kg	20.35 ± 1.63	7.15 ± 0.50	5.95 ± 0.42	4.15 ± 0.29	5.75 ± 0.40	7.30 ± 0.51
Lead (Pb)	mg/kg	1.20 ± 0.08	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

Twenty-three (23) elements are present in all the beans studied, magnesium, phosphorus, and sulfur are the major elements in these six varieties of *Phaseolus vulgaris*, and the content of these three elements differs only slightly from one variety to the next.

Table 6. Results of phytochemical screening

Chemical family	Test	Results obtained	Results of experiment	Conclusion
Alkaloids	Mayer	Precipitate	++	Presence of alkaloids
	Wagner	Precipitate	++	
	Dragendorff	Precipitate	++	
Flavonoids and anthocyanins	Wilstater	Red coloration	+	Presence of flavonoids and anthocyanins
	Modified Wilstater	Red coloration	+	
	Bate Smith	Red coloration	+	
	Bate Smith	Red coloration	+	
Tannins and Polyphenols	Gelatin 1%	Precipitate	+	Presence of tannins and polyphenols
	Gelatin	Green precipitate	+	
	Salted gelatin	Black-blue coloration	+	
Coumarins	UV Revelation	No change of color	-	Absence of coumarins
Carotenoids	Carr-Price	No change of color	-	Absence of carotenoids
Anthraquinones	Bôrnstrager	No change of color	-	Absence of anthraquinones
Saponosides (Saponins)	Foam test	Height of foam: 1 cm	-	Absence of saponins
Stéroids and triterpenes	Salkowski	No coloration	-	Absence of steroids and triterpenes
	Liebermann-Burchard	No coloration	-	
	Badjet-Kedde	No coloration	-	
Polysaccharides	Ethyl alcohol	No precipitate	-	Absence of polysaccarides
Deoxyoses	Keller-Kiliani	No ring purple	-	Absence of deoxyoses
Irridoids	HCl	No precipitate	-	Absence of irridoids

Significance of signs:

- Negative precipitation with no coloration and foam index 0 à 2cm (-)
- Weak precipitation with weak coloration and foam index 2 à 4 cm (+)
- Negative precipitation with nil coloration and moss index 0 à 2cm (-)
- Abundant precipitation with clear coloration and moss index 4 à 5 cm (++)
- Heavy precipitation with intense coloration and foam index greater than 5 cm (+++).

The chemical families present in the seeds are alkaloids, anthocyanins, polyphenols, tannins, and flavonoids. Alkaloids precipitated the most, followed by flavonoids and anthocyanins, while tannins and polyphenols precipitated the least. Thanks to the presence of these phytochemical families, these beans also have therapeutic values as a vein protector, anti-diarrheal, and antioxidant.

The differences between these varieties are characterized by the type of flavonoids, as shown in the following table (Table 7):

Table 7. Characteristics of flavonoids in samples

Sample	Flavonoid type
***Mena botakely* 55(B)**	Flavonols
RANJONOMBY RI 5-2	Flavones and flavanols
***Vangamena* CAL 98**	Flavones
FOFIFA *Ran'omby* 1 (DRK 64)	Flavones
***Ranjonomby* RI 5-3**	Flavonols
FOFIFA *Ran'omby* 4 (DRKF)	Flavonols

These substances are secondary or specialized metabolites. They are synthesized by plants, among other things, as protective agents, odorants, and colorants, but also as growth regulators.

IV. Conclusion

Biochemical analyses of beans have shown different nutrient contents from one variety to another. Beans are rich in carbohydrates, proteins, and ash, and therefore in mineral elements, but low in lipids. Combining beans with cereals such as rice, corn, wheat, etc. in a meal can correct their deficiency in sulfur amino acids. In addition, the presence of chemical families such as alkaloids, anthocyanins, polyphenols, tannins, and flavonoids verifies the beans' biological properties. The present work confirms the importance of beans in the human diet thanks to their satisfactory nutritional quality, especially the "*Ran'omby* 1" variety, 23.0134% protein.

Traditionally, beans have been eaten as an accompaniment to rice, but today the use of flour in bakery and pastry-making has developed. In certain preparations, this legume is used as a meat substitute due to the quality and quantity of proteins it contains and is considered a "memory aid" by many Malagasy households.

According to these physicochemical analyses, the grains that the Creator gave to man to eat and that He found "good" without explicit mention in the Scriptures of any scientific analysis is really good for today's *Homo sapiens*, and it's no wonder that the *Homo habilis* that appeared in Africa 2.4 (or perhaps 2.8) million years ago also ate them.

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