



ORGANIC PEA SPROUT IN DOOR TO IMPROVE PIE QUALITY

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ABSTRACT

Pea sprouts as kind of sprout vegetables, are considered to be more health- beneficial and nutritive. The effect of sprouting pea seeds at open field and laboratory on the green sprouts yield characters and their nutritional values were studied. Result revealed that number of shoots, fresh and dry yield of pea sprout per square meter was increased significantly under laboratory condition over open filed. Protein content was found to increase in green pea sprout at laboratory as compared with open field. Conversely trend was occurred for carbohydrate and lipids. Sprout grown under open filed had the highest content of P, K, Ca, Mg and Fe compared with laboratory ones. On the other hand, higher vitamin E and C (853.6 and 51.1 mg/100g, respectively) was observed as grown under open filed than laboratory (189.1 and 48.6 mg/100g, respectively). The effect of partial replacement of wheat flour with 12.5% and 25% of green and etiolated pea sprout flour on the sensory evaluation and amino acids profile of pea pie were also studied. Supplemented pie with etiolated pea sprout with 12.5% or 25% was more preferable by panelists than green sprout flour and nearly to control. The present work confirmed that the recommended supplementation of refined wheat flour should be up to 12.5% of pea sprout flour. Values of protein efficiency ratio (PER) of pea sprout pies were ranged from 1.06 to 1.69 which higher than control (0.76). The essential amino acid index (EAAI) of pea pie supplemented with 25% green pea sprouts was useful for food since the value is

above 80%. Also, the biological value exhibited the highest value in the same pie. However, highest nutritional index (NI) was obtained from pie supplemented with 25% green pea sprouts (23.46%) over other treatments. Therefore, combination of wheat flour with pea sprout flour can be recommended for high nutritional quality for human, Since it have good protein quality because the amino acid compositions of wheat and peas complement each other, producing a balanced mixture of amino acids.

INTRODUCTION

Legume seeds are important sources of energy and protein in many parts of the world, both in animal and human nutrition (Kaushik et al 2010). However, their nutritional value may be compromised in part by the presence of undesirable components, known as anti- nutritional factors (ANFs). Peas (*Pisum sativum L.*), an important food legume, are mainly used for grain production throughout the world. Pea seed contain a moderate amount of high quality protein and a high level of starch, thus making this crop a unique dual-purpose feed, rich in both energy and protein (Cousin, 1997). Germination process has been used for centuries for the purpose of softening the kernel structure, improving its nutritional value, reducing anti-nutritional effects and improving the functionality of seed protein (Kaukovirta-Norja et al 2004 and Ijarotimi and Keshinro 2013).

A sprout is one of the most complete nutrition of all foods tested. Sprouts contain vitamins, minerals, proteins and enzymes. The ancient Egyptians and Chinese, thousands of years ago, discovered their nutritional value, while seed germination and production of sprouts is an old habit that

was adopted thousands of year's age by the ancient (**Abdallah, 2008**). Sprouts can be considered as an organic food, that they were produced on farms that do not use chemical fertilizers or pesticides, since seed sprouting is the practice of soaking, draining and leaving seeds until they germinate and begin to sprout (**Frias et al 1995; Bau et al 1997 and Schulze et al 1997**). A diet based on organic products claims to provide health benefits due to the higher concentration of nutritional compounds compared to conventional ones, and the absence of pesticide residues (**Oates, 2014**). Many searchers study the effect of sprouting on the chemical composition of the seeds or grains. However, there is no study on the yield and seedlings growth under agricultural organic system. In addition, several workers like **Saha and Dunkwal, (2009); Tiwari and Awasthi, (2014) and Premakumari et al (2012)** etc. have prepared multi-grain mixes using cereals, pulses etc. However, limited studies were achieved on the nutritional quality of a combination of grains with sprouted pea flour. Thus, the objectives of this work were:

1. Effect of agricultural organic systems on the yield and nutritional value of sprouted pea seeds.
2. Influence of addition sprouted pea flour on the nutritional value of the pea pie.

MATERIALS AND METHODS

This study was carried out at winter season of 2015 and 2016 in Horticulture Department, Organic Agriculture Laboratory, Faculty of Agriculture, Ain Shams University, Kaluibia Governorate.

1. Material

Organic uniform seeds sizes of pea (*Pisum sativum*) cultivar Master B were obtained from certified privet farm in Ismailia Governorate, Pea green and etiolated sprouts grown in laboratory. The sprouts were air dried and ground in blender to tiny particles passing through 20 mesh sieve, i.e. similar to the size of wheat flour, wheat flour (72% extraction) , sugar, butter and yeast were obtained from organic local market.

2. Pea sprouts production

In a primary experiment green pea sprouts were grown in laboratory compared with open filled using mixed growing medium (45% vermiculite +

45% clay + 10% compost). Pea seeds were grown at winter season of 2015 and 2016 in plastic trays (7 shelves) in laboratory (1975 g of seeds / m²), while grown in 1x1 m in the open filed with 10 cm top layer growing medium recorded before. Selected green sprouts (13 days old) grown in plastic trays in laboratory were used comparing with one day old etiolated pea sprouts grown in glass jar were used for producing sprout flours for pie production.

3. Processing of Pea sprout pie

Sprout pie was prepared by partially replacing the wheat flour (72% extraction) with 12.5% and 25% of etiolated or green sprout flour, as compared with 100% wheat flour, the recipe of the pie was as follow: wheat flour or its mixture with sprout flours 200g, sugar 16g, butter 100g and yeast 6g.

Preparation was as follows: the ingredients were mixture together, rounded with adding water as needed for producing pie dough. Dough was punched immediately before panning. Pies were baked in oven at 230° C for 15 min as described before by **Hsu et al (1982)**.

4.2. Sensory evaluation

Pea pie samples coded with different numbers were presented to 10 trained panelists, who were asked to rote each sensory attribute by assigning a score of 10 for color, taste, texture and odor as described by **Sudha et al (2007)**.

4.3 Amino acid and nutritional quality

Amino acids determination was performed according to **AOAC (2012)**. Nutritional quality of the sprout samples was determined as the amino acid profiles. The essential amino acid index (EAAI) was calculated using the method cited by **Ijarotimi and Keshinro (2013)** according to following equation:

$$EAAI = \frac{\sqrt[8]{[Lys \times Thero \times Val \times Meth \times Isoleu \times leu \times Phynyl \times His]_a}}{\sqrt[8]{[Lys \times Thero \times Val \times Meth \times Isoleu \times leu \times Phynyl \times His]_b}}$$

Where: [lysine, isoleucine, valine, threonine, leucine, phenylalanine, histidine and methionine]_a in test sample and [lysine, isoleucine, valine, threonine, leucine, phenylalanine, histidine and methionine]_b; content of the same amino acids in casein as standard protein (%) **Ibrahim (2017)**. The nutritional index of the food samples was calculated using the formula below:

$$\text{Nutritional index [\%]} = \frac{\text{EAAI} \times \% \text{ protein}}{100}$$

The biological value [BV] was calculated according to **Oser (1959)** cited by **Mune-Mune et al (2011)** using the following equation:

$$\text{BV (biological value)} = 1.09 \times \text{EAAI} - 11.7$$

The Protein Efficiency Ratio [PER] was estimated according to the regression equations developed by **Alsmeyer et al (1974)** as given below: PER (Protein Efficiency Ratio) = $-0.468 + 0.454 (\text{LEU}) - 0.105 (\text{TYR})$.

Leu/Isolucine ratio was also calculated as shown by **Adeyeye (2013)**.

Amino acid scores (%) was calculated using the following formula reported by **Ibrahim (2017)**:

$$\text{Amino acid scores \%} = \frac{\text{Essential amino acids in sprouts (g / 100g cp)}}{\text{Casine standar for essential amino acids}} \times 100$$

*cp: crude protein

Calculation of other protein quality parameters

Determination of the ratio of total essential amino acids (TEAA) to the total amino acids (TAA), i.e. (TEAA/TAA), total sulphur amino acids (TSAA), percentage cysteine in TSAA (% Cys/TSAA), total aromatic amino acids (TArAA), total acidic amino acids (TAAA) and total basic amino acids (TBAA) were estimated from the results obtained for amino acids profiles.

4. Chemical analysis

4.1. Proximate analysis, minerals and vitamin content

Samples of green pea sprouts produced in laboratory were used for proximate analysis, minerals and vitamin content in comparing with open field sprout samples.

Percentages of moisture, crude protein, ether extract (lipid), crude fiber and ash were determined according to the methods described by **AOAC (2012)**. Total carbohydrate determined by subtracting. The energy value was calculated using the Atwater factor method $[(9 \times \text{fat}) + (4 \times \text{carbohydrate}) + (4 \times \text{protein})]$ as described by **Chinma and Igyor (2007)** and **Nwabueze (2007)**.

Potassium, magnesium, phosphorus, Calcium and iron determined according to the method described in the **AOAC (2012)**.

Vitamin E and C were measured as reported by **Leth and Sondergaro (1983)**.

5. Statistical analysis

The data were statistically analyzed by analysis of variance using completely randomized design and least significant difference (L.S.D) at 0.05 levels according to the method described by **Snedecor and Cochran (1980)**.

RESULTS AND DISCUSSION

1. Green pea sprouts characters in laboratory versus open field

Sprouts shoot height and number of leaves didn't significantly affected by open field and laboratory **Table 1**. While, production under open field (clay soil medium) resulted an increase in sprout shoot weight as compare with laboratory (vermiculite and clay medium "1:1 V:V" in corporate with 10% compost).

However, under laboratory condition, there are observable increases in number of seedlings and fresh yield of pea per square meter reached 613% and 174%, respectively over open field. On the other hand, fresh yield per square meter could increase to be 6363g as use seven shelves vertically.

In contrary, fresh yield per gram of seeds were increased at open field (2134g) over laboratory (460.3g). Seedling dry weight was take similar trend of fresh weight either per square meter or per gram of seeds **Table 1**. These means that presence of light was improved the growth of shoots in addition to the metabolic changes that take place during the different stages of germination. While the absence of light was resulted an etiolated seedlings which enhanced shoot length at laboratory (indirect sun light) over open field (about 21% increments). Similar result in the effect of laboratory condition vs. open field on pea shoot characters was obtained by **Anwar (2016)**. Despite everything, pea sprouts grown in laboratory allows obtaining good fresh sprouts all year around compared to open field (in winter only).

Table 1. Effect of sprouting in the open field vs. laboratory on green pea sprout characters

Characters	Open field	Laboratory	LSD (0.05)
Sprout shoots length (cm)	7.62	9.22	N.S
No. of leaves / sprout	3.13	3.00	N.S
Sprout shoot fresh weight (mg)	551	211	400.7
Sprout shoot dry weight (mg)	54.3	20.2	94.3
No. of shoots/m ²	603	30109+	1303.9
Fresh yield of shoots (g/m ²)	332.3	6363+	400.7
Fresh yield of shoots (g/kg of seeds)	2134	460.3	14.2
Dry weight of shoots (g/m ²)	32.73	608.8+	94.3
Dry weight of shoots (g/kg of seeds)	210.2	44.04	29.8

+ = 7 shelves = 7 m², N.S = not significant, LSD = Least Significant Difference Test.

2. Effect of sprouting in the open field vs. laboratory on the proximate analysis, mineral and vitamin of green pea sprout

Green pea sprouts were grown under two growth conditions, open field and laboratory using the same vermiculite and clay medium (1:1 v:v) incorporated with 10% compost. The proximate analysis, minerals and vitamin content are shown in **Table 2**. The results showed that there was about 24.1% reduction in moisture in sprouting under open field conditions compared with laboratory environmental conditions.

Protein content was found to increase about 19.2% in green pea sprouts grown at laboratory as compared with open field condition (on a dry weight basis).

These results may be due to the lower shoot dry weight in sprouts grown in laboratory (20.2 mg) compared with open field shoot dry weight (54.3 mg). Similar result was obtained by **Anwar (2016)**. Regarding to lipid content; growing sprouts under open field brought high lipid content (4.65 %) over laboratory (2.75 %) **Table 2**. Similar trend was observed for carbohydrate content and these results may be because that during germination the reserve of carbohydrates especially in legume seeds consumed as energy source to start germination and various processes occurring in the

seeds. Moreover, in open field, as direct sunlight is available the young seedling can photosynthesize causing an increase in carbohydrate content in compare with indirect sunlight at laboratory condition.

Table 2. Proximate analysis, minerals and vitamins content of green pea sprout shoots grown in open field and laboratory.

Nutrients	Open field	Laboratory
Moisture %	8.57 b	11.29 a
Protein %	44.3 b	52.8 a
Lipids %	4.65 a	2.75 b
Carbohydrates %	23.9 a	16.2 b
Fiber %	8.37 b	8.74 a
Ash %	10.21 a	8.22 b
Energy Kcal.	314.7 a	300.8 b
Minerals (mg/100g)		
P	820 a	750 b
K	3480 a	2760 b
Ca	224 a	79 b
Mg	300 a	160 b
Fe	6.42 a	4.98 b
Vitamins (mg/100g)		
Vit. E	853.59 a	189.12 b
Vit. C	51.12 a	48.57 b

Means in each row followed by the same letter are not significantly different at the 5% level.

Highest fiber content was recorded at laboratory condition. Growing sprouts under open field condition caused an increase in ash content in compare with laboratory condition. However, **Santos et al (2014)** showed that pea leaves had a high water (91.5%) and low fat (0.3%) and carbohydrate (1.9%) contents, being a good source of dietary fiber (2.1%) compared to other ready-to-eat green leafy vegetables.

As estimated the energy value of pea sprouts shoot, it would be 314.7 Kcal for open field while it was 300.8 Kcal for laboratory. Thus, pea sprouts can provide human body with different nutrients with low calorie. **Pérez-Balibrea et al (2008)** reported that pea seedling, as kind of green sprout vegetable, is considered to be more health-beneficial and nutritive. Although, pea seedling has only ten or dozens of days for growth, light environment is an important and adjustable factor

which has potential in regulating yield and nutritional quality. It can be concluded that open field cause an improvement in the nutrition value of pea sprouts; however, produce sprouts under laboratory enhance its protein content with low fiber content and this may be preferable for many consumers.

Table 2 also presents the elements content of green pea sprouts grown under two sprouting conditions. Sprouts grown in the open field had the highest content of phosphorus, potassium, calcium, magnesium, and iron (on dry weight basis) compare with laboratory condition. The increment in elements content in the open filed condition may be related to the presence of light during the sprouting process and the absorption of elements from open field growing medium as reported before by **Anwar (2016)**. However **Santos et al (2014)** reported that pea shoots showed a high content of potassium and phosphorous compared to other ready-to-eat green leafy vegetables.

Also, **Ahmed (2014)** showed that the content of K of turnip and radish sprouts increased under open field conditions with clay + vermiculate (1:1 v/v) + 10% compost (8640 and 9310 mg/100g, as dry weight respectively). The obtained results confirmed that minerals content were affected by growing media and environment. Although, vermiculite with clay medium was used at laboratory and open field, sprouts under open field condition contain 183% of Ca and 87.5% of Mg more than content under laboratory condition.

Green pea sprouts grown in the open field contained higher vitamin E and C than those of laboratory grown sprouts **Table 2**. These results may be due to the presense of direct light under open field condition. Usage mixed growing medium (verm. + clay + 10% compost) in the open field enhanced sprout's content of vitamin E and C.

The results tend to open field condition is more suitable for produce green pea sprouts with high content of vitamin E and C, especially with using verm. + clay + 10% compost medium.

During sprouting (germination) several enzyme systems become active and bring about profound changes in the nutritive value of pulses. Vitamin C, which was practically absent in dry legume seeds, increased in amounts after sprouting (**Pallanca and Smirnof (1999)** and **Shah et al (2011)**). However, **Santos et al (2014)** reported that pea shoots showed a high content of vitamins C, E and A compared to other ready-to-eat green leafy vegetables.

3. Sensory evaluation of pie supplemented with pea sprouts flour

The average results for the pie taste of the market flour (control) and supplemented peas sprout flour are shown in **Table 3**. The maximum mean taste and color value were observed in T₃ (12.5% ESF : 87.5% WF) with no significant different than control pie while the minimum mean value were recorded in T₄ (25% GSF : 75% WF). Statistical analysis showed that supplementation had significantly influenced taste and color of the pies. Results exhibited a decrease in the quality of green pea sprouts flour 12.5% and 25% supplemented pies followed by 25% of etiolated pea sprouts flour supplemented pies in terms of taste and color.

Table 3. Sensory evaluation of pea pie as affected by replacement of wheat flour with 12.5% and 25% of etiolated and green sprouted pea seed flour

Supplementation levels	Taste	color	texture	Odor
(Control ,WF) T ₁	8.4 ab	8.9 a	9.0 a	9.2 a
(12.5% GSF : 87.5% WF) T ₂	6.5 c	6.5 c	8.0 bc	6.5 b
(12.5% ESF : 87.5% WF) T ₃	8.9 a	8.8 a	8.4 ab	9.0 a
(25% GSF : 75% WF) T ₄	5.7 d	6.0 c	7.4 c	5.8 b
(25% ESF : 75% WF) T ₅	7.9 b	7.8 b	8.1 bc	8.6 a
LSD (< 0.05)	0.64	0.63	0.70	0.80

WF: wheat flour, GSF: green pea sprouts flour and ESF: etiolated pea sprouts flour

Means in each raw followed by the same letter are not significantly different at the 5% level.

The decrease may be attributed to the dry leafy greens flavor of green pea sprouts flour; however, supplemented with etiolated pea sprouts flour provide pies with beany or nuts flavor. Similarly, the maximum mean values (8.9 and 8.8) were noted in T₁ (Control, WF) and T₃ (12.5% ESF : 87.5% WF), whereas the minimum mean value (6.0) was found in T₄ (25% GSF : 75% WF). The dark color dominated with the gradual increase in green pea sprouts flour.

The average results for the texture of the control and supplemented pies also are shown in **Table 3**. Statistical analysis revealed that the texture score of the pies had significantly decreased with the progressive increase in pea sprouts supplementation especially in green sprout flour and the

high value (9.0) was recorded in T₁ (control) followed by T₃. The decrease may be due to the increase in fiber content of pea sprout flour blend. Maximum mean value of odor was observed in T₁ followed by T₃ (12.5% ESF: 87.5% WF) and T₅ (25% ESF : 75% WF), which were not significantly differed **Table 3. Pomernaz et al (1977)** reported that bread supplemented with 10% flour from germinated soyabean resulted in highly satisfactory bread quality. While, **Finney (1977)** showed that replacing 7% wheat flour with wet, mashed and germinated soyabean produced bread with no objectionable taste or odor. **Finney et al (1980)** replaced 15% of wheat flour with germinated, ungerminated and dehulled faba bean, they produced acceptable breads using both the sugar and sugar-free formulas. However, **Hsu et al (1980)** reported that germination adversely affected baking properties of yellow peas and lentils but not faba bean. The adverse effect of germination on baking properties of legume flours is partly due to changes in starch (**Morad et al 1980**). **Abdallah and Abo El-Naga (2013)** reported that using unsieved sprouted whole wheat grain flour and dehulled sprouted faba bean seed flour with sprouted naked barley flour for cake production, showed that there are no significant difference between control treatments and 100% or 50% sprouted whole wheat grain flour substitution treatments for sensory attributes crust color and crumb appearance. Moreover, **Abdallah et al (2017)** reported that the replacements of wheat flour by seeds sprout flours at different levels could improve nutritional quality, physical characteristics and sensory characteristics of produce cupcakes especially when using of sprouted faba beans and chickpea flour. Also, **Ibrahim (2017)** recorded that the best biscuit samples were prepared from sprouted wheat supplement with 50% sprouted chickpea flour which recorded the highest panel test (7.9) and color (8.1) but it occupied the third texture test (8) after soft (8.8) and coarse (8.3) market flour biscuits.

Overall; supplemented pies with white (etiolated) pea sprout either with 12.5% or 25% was more preferable by panelists and nearly to control. The presents work confirmed that the recommended supplementation of refined wheat flour should be up to 12.5% of green pea sprouts flour and up to 25% of etiolated sprouts flour, which could produce acceptable pies with high nutritional quality.

4. Effect of supplemented wheat flour with pea sprouts flour on the amino acids profile and nutritional quality of pea pie

The incorporation of ingredients like legume flour, concentrate or isolate in cereal-based matrices can lead to the production of nutritionally enhanced products like bread with high protein content. Many studies have been made on the supplementation of wheat flour with legume based ingredients like lupin flour (**Paraskevopoulou et al 2010**), pea flour (**Morad et al 1980**), faba bean flour or concentrate (**Abdallah and Abo El-Naga, 2013 and Abdallah et al 2017**), chickpea flour (**Abdallah et al 2017 and Ibrahim, 2017**) and soy protein flour or isolate (**Khan and Lawhon, 1980**) to produce enriched bread and bakery products. Substitution with legume-based products allows to improve bread protein content and to compensate wheat deficiencies in lysine and threonine, two essential amino acids (**Kies and Fox, 1970 and Pollard et al 2002**). Amino acids content and nutritional quality of pies supplemented with 12.5% of green and etiolated pea sprouts flour (T₂ "12.5% GSF: 87.5% WF" and T₃ "12.5% ESF: 87.5% WF") and 25% of green and white pea sprouts flour (T₄ "25% GSF: 75% WF" and T₅ "25% ESF: 75% WF") as compare with 100% wheat flour (T₁, control) are presented in **Table 4**. Data showed that glutamic acid was found to be the most abundant in T₄ (23.44 g/100g cp.) followed by T₂ (19.94 g/100g cp.), T₅ (18.02 g/100g cp.) and T₃ (15.33 g/100g cp.) while T₁ control (11.74 g/100g cp.) was the lowest. Similar results were reported by **Roohinejad et al (2009)**, **Moongngarm and Saetung (2010)** and **Ijarotimi (2012)**. However, **Bak et al (2006)** found that decarboxylation of glutamic acid increased Gama Amino Buteric acid (GABA) synthesis, as of the most interesting compounds in germinated cereal grains which plays a vital role in central nervous system, as inhibitory neurotransmitter and it has hypotensive effect on blood pressure (**Xu and Godber, 2001**). On the other hand, methionine was the least in all treatments (ranged from 0.84 g/100g in T₁ to 1.32 g/100g in T₄). Also, limited amino acid cysteine was found in all treatment which ranged from 0.90 g/100g in T₁ to 3.74 g/100g in T₄. Generally, sprouting caused an increase in the content of almost amino acids especially in pie prepared from green pea sprout flour except arginine and aspartic acid and this results were in agreement with **Shu et al (2008)** and **Moongngarm and Saetung (2010)**, they found about similar results.

Table 4. Amino acid profile and nutritional quality of pea sprouts pie

		T ₁	T ₂	T ₃	T ₄	T ₅ ⁽¹⁾
	Casein standard	Essential amino acids (g/100g cp.)				
Theronine	3.78	1.73	1.84	2.14	1.87	2.16
Valine	5.82	3.05	3.85	3.29	4.53	3.87
Isoleucine	4.54	1.67	2.5	2.14	2.90	2.48
Leucine	8.28	3.29	4.72	3.90	5.53	4.56
Phenylalanine	4.55	2.81	3.36	2.69	4.15	3.31
Histidine	2.55	1.31	1.57	1.20	1.92	1.47
Lysine	7.09	1.73	1.41	1.75	1.59	1.98
Methionine	2.57	0.84	1.25	1.04	1.32	1.11
Total (EAA)	39.18	16.46	20.54	18.19	23.82	20.97
Conditionally essential amino acids (g/100g cp.)						
Tyrosine		2.51	2.93	2.36	3.32	2.67
Arginine		3.05	2.11	2.36	2.44	2.71
Cysteine		0.90	2.17	0.98	3.75	1.70
Proline		2.15	6.84	3.90	8.41	4.79
Glycine		1.97	2.66	2.14	3.32	2.67
Non-essential amino acids (g/100g cp.)						
Aspartic acid		11.91	3.42	4.12	3.87	4.65
Serine		2.03	2.55	2.91	2.55	2.90
Gluctamic acid		11.74	19.95	15.33	23.44	18.02
Alanine		2.51	3.04	2.41	3.94	3.13
Total (NEAA)		38.80	45.70	36.53	55.04	43.27
Total amino acids		55.26	66.25	54.72	78.87	64.23
Parameters		Nutritional quality⁽²⁾				
TEAA/TAA %		29.79	31.00	33.23	30.21	32.63
TNEAA/TAA%		70.20	68.99	66.76	69.79	67.36
TEAA/TNEAA		0.42	0.44	0.49	0.43	0.48
TSAA(Meth. + Cys)		1.73	3.42	2.03	5.07	2.81
Cys / TSAA %		51.72	63.49	48.64	73.89	60.65
TArAA (Pheny + Tyr)		5.30	6.30	5.05	7.47	5.99
Leu / Isoleu		1.96	1.89	1.82	1.90	1.83
TAAA (Asp + Glu)		23.65	23.36	19.45	27.31	22.67
Asp/ Glu		1.01	0.17	0.26	0.16	0.25
TBAA (Arg + Lys)		4.79	3.53	4.12	4.03	4.70
TEAA+Arg+His/TAA %		37.70	36.58	39.75	35.74	39.16
PER		0.76	1.37	1.06	1.69	1.32
EAAI %		86.02	84.90	87.70	84.1	87.1
BV %		82.06	80.84	83.89	79.96	83.20
Nutritional index %		14.37	15.45	16.14	23.46	18.89

(1)T₁= 100% wheat flour (control), T₂ = 12.5% green pea sprout flour, T₃ = 12.5% etiolated pea sprouts flour, T₄ = 25% green pea sprout flour and T₅ = 25% etiolated pea sprouts flour

(2) TEAA=total essential amino acids, TAA=total amino acids, TNEAA=total non-essential amino acids, TSAA=total sulphur amino acids, TArAA=total aromatic amino acids, TAAA=total acidic amino acids, TBAA= total basic amino acids, PER= Protein Efficiency Ratio, EAAI =essential amino acid index, BV= biological value.

The results of protein quality of sprouted pea pie were also presented in **Table 4**. The percentage of total essential amino acids showed that T₄ had the highest value compared with T₁ control. The total aromatic amino acids (TArAA) of pea sprouts pie were ranged from 5.05 to 7.47 g/100g cp. Pea sprouts pie at all treatments showed higher percentage ratio of total essential amino acid (TEAA) to the total amino acids (TAA) (from 30.21% to 33.23%) as compared with control pie (29.79%). These values were close to the value of 39% considered adequate for ideal protein food for infants and above the 26% for ideal protein food for children and 11% for adult (**FAO/WHO/UNU, 1985**). Total acidic amino acid (TAAA) ranged from 19.45% to 27.31% in sprout and control pies, which was higher than total essential amino acid (TEAA) whilst, the percentage range in total basic amino acid (TBAA) from 3.53 to 4.79% that made them the third largest group among the pea pie samples.

An observation in Asp/Glu showed that the highest level was found in T₁ relative to the other treatments. While Leu/Ileu ratio was almost similar in pea pie sample (especially T₄) compared with control (T₁). Most of pie samples contain more Cys than Meth. for examples Cys/TSAA percentage was 73.9% for T₄ compared with control (T₁) which recorded 51.7% **Table 4**. **Adeyey, (2004)** reported that many vegetables proteins contains substantially more Cys than Meth. In contrast animal proteins are low in Cys (**Adeyeye and Ayejuyo, 2007**). However the present pea sprout pie sample results Cys/TSAA. Cys has positive effects on mineral absorption particularly zinc (**Sandstrom et al 1989 and Mendozd, 2002**).

The most widely used method for measurement of protein quality is protein efficiency ratio (PER) test, which is the weight gained by the rats (biological assays) divided by the weight of protein consumed. Nowadays, **Alsmeyer et al (1974)** equations using amino acid (AA) practical and less expenses and time required for the assay test. The values of protein efficiency ratio (PER) of the pea pie samples were between 0.76 in T₁ (control) to 1.69 in T₄ (25% GSF: 75% WF). However, the protein efficiency ratio (PER) in pea sprout pies were less than 2.5 which found in reference casein (**Oyarekua and Eleyinmi, 2004**), but they were variably compared to millet *ogi* (1.62) (**Oyarekua and Eleyinmi, 2004**).

Protein quality can also be measured using biological value (BV) and essential amino acid index (EAAI). The essential amino acid index EAAI

of T₃ and T₅ had the highest value (about 87.7 and 87.1%) over other treatments. The essential amino acid index EAAI of all treatment was useful for food since the values are above 70%. **Oser (1959)** reported that protein based food is in adequate when it's EAAI below 70% and useful since EAAI value is around 80%.

Scientifically, it is well known that a protein-based food nutritional is a good nutritional quality when its biological values (BV) are high (70% to 100%) (**Oser, 1959**). BV exhibited the highest value in T₃ (83.9%) followed by T₅ (83.2%) and T₄ was the lowest (79.9%). Data in **Table 4**. showed that T₁ recorded the lowest nutritional index NI (9.86%).

In contrast, the highest NI was obtained in T₄ (23.46%). Wheat is a low in some essential amino acids, notably lysine. Therefore, the traditional wheat-based food product, e.g biscuits are generally of poor nutritional quality for human and this could have been the reason for the high prevalence of the protein malnutrition among weaning aged children in developing countries, where cereals are solely used as complementary foods (**Oko-ye, 1992 and Devlin, 1997**).

5. Amino acids score

Essential amino acid score expressed as percentage of the content of each essential amino acid in the sample protein to the same essential amino acid in the same quantity of a protein selected as a standard (Casein). The essential amino acid showing the lowest percentage in called (first limiting amino acid) in the test sample protein. The true limiting amino acid in the protein is, however, the amino acid limiting growth in biological experiment. Data in **Table 5**. showed that the first limiting amino acid score was Lysine (19.9 to 27.9%) in all treatments, followed by Methionine (32.6 to 51.5%).

Finally sprouting pea seeds in simple language tills human how to become a mini organic gardener in his own home.

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