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# Study and Formulation of a Dietary Cold Sauce Based on Pumpkin Seed Oil and Quail Eggs

Koumba Hawa Toundoufedouno[1], Kédoua Kourouma[1] and Adama Moussa Sakho[2]

*1. Laboratory of Food and Nutritional Sciences, Higher School of Tourism and Hospitality of Conakry, Conakry 766, Republic of Guinea*

*2. Department of Laboratory Techniques, Higher Institute of Technology of Mamou, Mamou 063, Republic of Guinea*

**Abstract:** This work focuses on the formulation of a dietary cold sauce, mayonnaise, which combines the therapeutic properties of two basic ingredients: PSO (Pumpkin Seed Oil) and quail egg, both of which are renowned for their high functional properties. PSO is essentially made up of unsaturated fatty acids (50% to 65%) including linoleic acid, from the omega 6 family, oleic acid (20% to 50%), a monounsaturated fatty acid (omega 9), cucurbitin, phytosterols, tri-terpenes and vitamin E (3.5 mg%). The nutritional, fatty acid, vitamin and mineral compositions of the mayonnaise compared with the ingredients, the physico-chemical characteristics of the quail egg, the PSO and the tasting of the mayonnaise were determined and gave results in terms of variable contents which are recorded in Tables 2-8. The results obtained were satisfactory. Mayonnaise, a semi-solid emulsion of oil in water with viscoelastic properties due to the network formed by lipoproteins adsorbed around neighbouring drops of oil, was prepared using the ratio of quail egg and PSO 1/4. This study may offer an alternative way of making dietary sauces.

**Key words:** Nutritional study, food formulation, dietary sauce, PSO, quail eggs.

## 1. Introduction

In a context where health and nutrition are increasingly at the heart of concerns, dietary diversity such as the development of dietary sauces is becoming essential to meet the needs of a balanced diet without sacrificing taste, as well as combating malnutrition [1, 2]. Sauces play a key role in cooking. They accompany various raw or cooked dishes, adding flavour and texture, but they are often high in saturated fat and calories and improve the colour of dishes [3, 4]. Difficulties in preserving meat and fish in the Middle Ages led to the development of sauces, either to extend their shelf life or to improve their flavour [5]. Over the centuries, different cultures and populations around the world have developed their own recipes for famous sauces, from Asia, Latin America, Africa and Europe to the Middle East [6, 7]. However, Guinean gastronomy varies from one region to another, with different types of dishes based on cassava, rice, fonio and maize, prepared in different ways with a variety of sauces to suit different tastes and preferences: cassava leaves, sweet potato, spinach, fresh or powdered okra, peanut paste, and so on [8]. Many authors have worked, and others continue to work, on the preparation and development of numerous sauces, either by improving existing ones or by creating new ones. It is with this in mind that the present work proposes to develop a dietary cold sauce using ingredients that are beneficial to health, such as PSO (Pumpkin Seed Oil) and quail egg. PSO, known for its richness in unsaturated fatty acids and antioxidant properties, is an ideal base for a healthy sauce [9]. Combined with quail egg, which is a valuable source of protein and vitamins, this formulation aims to create a nutritious product. The aim of this study is to design a sauce that combines taste, nutrition and ease of preparation, while meeting the requirements of a healthy diet. In addition to the formulation, the study will focus on nutritional aspects,

**Corresponding author:** Koumba Hawa Toundoufedouno, Doctoral student, research field: chemical food.

preparation techniques, culinary applications and preservation methods to guarantee the quality and effectiveness of this sauce (mayonnaise) in a dietary context.

## 2. Materials and Methods

### *2.1 Materials*

This work focuses on the preparation of a diet mayonnaise based on quail egg and PSO in a ratio of 1/4.

2.1.1 Biological Materials

Whole quail eggs and PSO were used as raw materials in this work.

2.1.2 Technical equipment

The technical equipment used is a hand blender or whisk, a glass or stainless-steel bowl, an analytical balance, an incubator, a pH meter, a pipette or container for adding the oil in a thin stream, an oil extractor, a spoon and spatulas for homogenising the preparations. The analysis reagents used are ethanol, silver nitrate solution and potassium bicarbonate solution.

### *2.2 Methods*

2.2.1 Preparation of Mayonnaise Samples

Diet mayonnaise with quail eggs (Fig.1) and PSO is a nutrient-rich assortment, particularly suitable for special diets. To guarantee homogenous samples suitable for analysis, the ingredients used for a mayonnaise of around 200 mL are: PSO, 100 mL, whole quail eggs, 5 units approximately 20 g, vinegar 8° or concentrated lemon juice or citric acid, 1 tablespoon i.e. 5 mL, salt, 1 pinch, maltodextrin (sweetener), xanthan ¼ teaspoon, EDTA (Ethylene Diamine Tetra Acetate), ¼ teaspoon. Samples were prepared according to the formulation (Table 1).

2.2.2Preparation Methods

2.2.2.1 Preparation of the Aqueous Phase

Thickener, Maïzena (starch), acidifier (vinegar), mustard, salt, flavouring and antioxidant (oxidation) have been added to the sampled water. Mix the maltodextrin, cornflour, salt and pepper in a small bowl. Then, in a bowl, add the water and whisk the dry ingredients until completely dissolved. Next, add the 8° white wine vinegar, mustard and lemon juice concentrate and stir until a homogeneous solution is obtained. Gently heat the aqueous phase to around 60-70 ℃ to activate the thickening of the cornflour. Allow cooling to room temperature before proceeding to the next step.

2.2.2.2 Preparation of the Discontinuous or Oily Phase

In a separate bowl, mix the quail egg yolks (emulsifier) with the xanthan gum (colouring agent). Whisk until well blended. Then drizzle in the PSO very slowly while whisking continuously to start forming an emulsion.

**Fig. 1 Quail eggs.**

**Table 1 Diet mayonnaise formulation.**

| Constituents | | Units | Content |
|---|---|---|---|
| (I) Continuous/aqueous phase | | | |
| Diluent | Water | g%g | 36.78 |
| Sweetener | Malto dextrin | g%g | 5 |
| Thickener | Maizena | g%g | 3.1 |
| Acidifier | White wine vinegar 8° | g%g | 3 |
| | Strong mustard | g%g | 2.2 |
| | Salt | g%g | 1.5 |
| Flavouring | Spices (pepper) | g%g | 0.1 |
| Anti-oxidant | Concentrated lemon juice | g%g | 0.2 |
| (II) Interruption/oil phase | | | |
| Emulsifier | PSO | g%g | 38 |
| Emulsifier | Quail egg yolk | g%g | 10 |
| Colouring | Xanthane | g%g | 0.22 |
| Total | | g%g | 100 |

(1) Assembling the Two Phases

These two phases have been prepared separately and homogenised to form the mayonnaise, i.e. once the oil phase has been pre-emulsified, start to slowly incorporate the water phase while continuing to whisk, then use an immersion blender if necessary to obtain a smooth, homogenous texture.

(2) Adjustments and Conservation

Check the texture and seasoning, adding a small amount of salt, pepper or lemon juice if necessary. Then place the resulting mayonnaise in a glass jar and chill in the fridge at a temperature of 6 °C.

(3) Assessing the Nutritional Quality of a Diet Mayonnaise

The dry matter content of the raw materials and mayonnaise was determined by drying in an oven at 105 ℃ to constant weight according to the AACC 44-15A method by the Kjeldahl method of the NF V03-050 standard [10]; lipids were determined by the Soxhlet gravimetric method with the international standard ISO 659, 1988 [11]. Carbohydrates and fibers were determined by the AOAC 985-29 method; ash content was determined by the AACC 08-01 method [12]. Micronutrients, iron and zinc were determined by UV-VIS spectrophotometry (DR 5000; HACH and LANGE, France), vitamin contents were determined by reverse-phase HPLC (High-Performance Liquid Chromatography) at 280 nm.

(4) Physicochemical Characteristics of Diet Mayonnaise

- Determination of acidity, pH

These contents were determined according to the procedure described in the literature [13].

- Determination of salt content (NaCl)

This method for determining sodium chloride content is applicable to all fatty substances.

- Principle

After melting the mayonnaise by adding boiling water, the chlorides of the mixture are titrated with a standard solution of silver nitrate ($AgNO_3$), in the presence of potassium chromate ($K_2CrO_4$) as a colored indicator, according to the MOHR method (ISO 885/1.02.2004).

- Operating mode

Weigh to the nearest 0.01 g approximately 5 g of the sample from an Erlenmeyer flask. Carefully add 100 mL of boiling distilled water. Allow standing for 5 to 10 min, stirring periodically until the mixture reaches 50 to 55 ℃ (assay temperature). Then add, with stirring, 2 mL of the potassium chromate solution. Subsequently titrate with the silver nitrate solution until the brick red colour change persists for 30 s. The concentration was calculated according to the formula:

$$C_{NaCl} = \frac{5.85 * (V_1 - V_2) \times 0.1}{M_0}$$

Or

$C_{NaCl}$ = concentration of table salt; $V_1$ = volume of Ag $NO_3$ solution consumed for titration of the sample; $V_2$ = volume of Ag $NO_3$ solution consumed for titration of the blank test; $M_0$ = mass of the sample taken.

- Determination of viscosity

The viscosity or consistency of mayonnaise was assessed by measuring the flow distance expressed in mm/30 s, using a Bostick consistometer.

- Quality and microbiological conservation of mayonnaise

Mayonnaises are relatively fragile products from a microbiological point of view and some ingredients such as fresh egg yolk are often contaminated. The amount of water available to microorganisms, the pH around 4.0 (to stop or eliminate the growth of pathogenic germs) are the key factors for the stability of mayonnaise [14]. A control based on good manufacturing practices, as well as on the quality of the raw materials, particularly eggs, is decisive for the quality of the finished product. In addition, one should not forget the control of the air as well as the packaging used.

- Sensory analyses

The organoleptic quality indicators of the mayonnaise samples were determined according to the following criteria: appearance, colour, odour, flavour and texture. The organoleptic evaluation was carried out by a panel of 30 tasters.

- Sensory evaluation

In this work, the following sensory characteristics were tested namely: observation and physical appreciation of the sample, odor, flavor, color, texture, etc..

## 3. Results

Table 2 shows the contents of the ingredients used for the manufacture of this mayonnaise and the nutritional composition of the prepared mayonnaise which give variable values with very high contents of dry matter, cholesterol/phytosterol and lipid, namely: 98.9 g% oil, seed and pumpkin associated, 106 g% and 98 g% respectively. With a high content of cholesterol/phytosterol in the quail egg, namely: 836 mg%. However, the mayonnaise in dry matter is at: 87.47 g% and contains 245.22 mg% of cholesterol/phytosterol.

The fatty acid and linolenic acid contents of mayonnaise made from PSO and quail eggs are shown in Table 3. As a result, PSO contains high concentrations of saturated fatty acids (palmitic and stearic) and polyunsaturated fatty acids (linoleic and gamma-linolenic). This reflects its richness in lipids and essential fatty acids. CE (Quail Eggs), rich in oleic acid, with lower levels of saturated and polyunsaturated fatty acids, contribute significantly to monounsaturated fatty acids. Mayonnaise dilutes the fatty acid concentrations of the base ingredients while retaining some characteristics of the polyunsaturated fatty acids. This analysis helps to understand how the formulation of mayonnaise influences its fatty acid composition relative to its base ingredients.

**Table 2 Comparative nutritional composition of mayonnaise and its manufacturing ingredients.**

| Nutrients | Units | HPC | OC | Mayonnaise |
|---|---|---|---|---|
| Dried material | g% | 98.9 ± 2.36 | 25.3 ± 1.27 | 87.47 ± 2.19 |
| Water | g% | 1.1 ± 0.01 | 74.7 ± 2.51 | 12.53 ± 0.07 |
| Proteins | g% | 0.7 ± 0.004 | 12.5 ± 0.82 | 3.41 ± 0.052 |
| Lipids | g% | 98 ± 0.54 | 11.1 ± 0.36 | 82.5 ± 0.71 |
| Saturated fatty acids | g% | 22 ± 0.23 | 3.45 ± 0.04 | 6.54 ± 0.026 |
| AMI | g% | 26 ± 0.34 | 4.55 ± 0.042 | 45.28 ± 0.37 |
| API | g% | 52 ± 0.72 | 1.28 ± 0.041 | 7.44 ± 0.05 |
| Cholesterol/Phytosterol | mg% | 106 ± 1.36 | 836 ± 5.34 | 245.22 ± 3.45 |
| Carbohydrates | g% | - | 0.45 ± 0.003 | 0.19 ± 0.004 |
| Fibers | g% | - | - | 0.02 ± 0.001 |
| Ashes | g% | 0.2 ± 0.001 | 1.25 ± 0.005 | 1.52 ± 0.004 |
| Energy | kcal | 887 ± 3.27 | 117 ± 0.86 | 750 ± 5.47 |
| | kJ | 3,706.4 ± 3.15 | 488.4 ± 0.96 | 3,136.5 ± 7.47 |

HPC = oil, seed, squash, OC = quail egg, AMI = monounsaturated acid, API = polyunsaturated acid.

**Table 3 Comparative fatty acid composition of mayonnaise and its manufacturing ingredients.**

| Fatty acids | Units | HPC | OC | Mayonnaise |
|---|---|---|---|---|
| Palmitic acid | mg% | 16.84 ± 0.14 | 8.67 ± 0.06 | 4.840.008 |
| Stearic acid | mg% | 7.8 ± 0.05 | 4.3 ± 0.04 | 5.2 ± 0.004 |
| Oleic acid | mg% | 5.63 ± 0.03 | 16.4 ± 0.07 | 7.3 ± 0.007 |
| Linoleic acid | mg% | 36.95 ± 0.16 | 3.8 ± 0.008 | **4.7** ± 0.25 |
| Linolenic acid | mg% | 7.5 ± 0.07 | 5.7 ± 0.005 | **9.25** ± 0.007 |
| G linolenic | mg% | 40.47 ± 0.23 | 1.3 ± 0.004 | 1.2 ± 0.003 |

**Table 4 Comparative vitamin composition of mayonnaise and its manufacturing ingredients.**

| Vitamins | Units | HPC | OC | Mayonnaise |
|---|---|---|---|---|
| Vitamin B1 | mg% | - | 0.15 ± 0.002 | 0.06 ± 0.005 |
| Vitamin B2 | mg% | - | 0.83 ± 0.007 | 0.1 ± 0.001 |
| Vitamin B3 | mg% | - | 0.17 ± 0.006 | 0.02 ± 0.003 |
| Vitamin B5 | mg% | - | 1.82 ± 0.004 | 2.6 ± 0.005 |
| Vitamin B6 | mg% | - | 0.18 ± 0.003 | 0.08 ± 0.001 |
| Choline | mg% | - | 15.4 ± 0.16 | 17.9 ± 0.09 |
| Vitamin B8 | mg% | - | 20.6 ± 0.23 | 13.2 ± 0.07 |
| Vitamin B9 | µg % | - | 0.72 ± 0.002 | 25.0 ± 0.11 |
| Vitamin B12 | µg % | - | 1.65 ± 0.004 | 1.52 ± 0.008 |
| Vitamin A | µg % | - | 162.3 ± 0.09 | 10.8 ± 0.07 |
| Vitamin D | µg % | - | 1.54 ± 0.005 | 1.24f ± 0.006 |
| Vitamin E | mg % | 3.5 ± 0.005 | 1.12 ± 0.001 | 2.3 ± 0.007 |
| Vitamin K | µg % | - | 0.41 ± 0.001 | 0.102 ± 0.003 |
| Salt | g% | - | - | 647.15 ± 0.002 |

According to Table 4 the content of vitamin B5 (2.6 mg%) in mayonnaise contains a higher amount of vitamins compared to quail egg (1.82 mg%). Choline and vitamin B9 are also more present in mayonnaise, suggesting that processing the ingredients into mayonnaise may increase the concentration of some vitamins. However, for other B vitamins, such as vitamin B2, B3, B6, and B8, mayonnaise has lower levels than quail egg. Vitamin A is much lower in mayonnaise (10.8 µg%) compared to quail egg (162.3 µg%), indicating possible degradation during the manufacturing process. Vitamin E is more present in mayonnaise (2.3 mg%) than in quail egg (1.12 mg%) but less than in PSO (3.5 mg%), probably due to the addition of oil. Vitamins D and K are slightly lower in mayonnaise compared to quail egg. Choline, an essential nutrient present in high amounts in eggs, is more concentrated in mayonnaise (17.9 mg%) than in OC (15.4 mg%), which shows some preservation or increase of this vitamin in the final product. The levels of derived vitamins such as B12 and B9 show that mayonnaise has a similar or slightly lower concentration compared to quail egg. The processing of the basic ingredients into mayonnaise influences the vitamin concentrations. Some vitamins see their concentration increase (such as B5 and choline), while others, such as vitamin A, decrease significantly. The manufacturing process and the proportions of the ingredients play a crucial role in these variations.

Sodium (Na) is significantly higher in mayonnaise (530 mg) compared to OC and other constituents which only contain 152 mg sodium, probably due to the addition of salt (NaCl) during manufacturing, which is consistent with common mayonnaise preparation practices. Potassium (K) decreases significantly in mayonnaise with a concentration of 60 mg, while OC contains 145 mg. This could be due to dilution by other ingredients or losses during the manufacturing process. Magnesium (Mg) is also reduced in mayonnaise, probably due to the same reasons as for potassium, namely dilution or loss during processing. As it is observed that during the process, OC has 15 mg magnesium, compared to 5.09 mg in mayonnaise. There is a decrease in calcium (Ca) in mayonnaise compared to its ingredients, which may be related to dilution, i.e. 38 mg for 67 mg calcium present in OC. Mayonnaise has about half the phosphorus (P) (122.2 mg) compared to OC (250 mg), suggesting a loss or dilution of the mineral during manufacturing. Unlike other minerals, iodine (I) is more concentrated in mayonnaise (36.08 µg) compared to OC which contains only (18 µg) iodine. This may be due to the addition of iodized ingredients, such as iodized salt. Iron (Fe) content is significantly higher in mayonnaise (21 mg), compared to OC (3.71 mg), which could be due to the use of iron-enriched ingredients or an increase in its bioavailability after processing. Copper (Cu) is reduced in mayonnaise from 0.03 mg to 0.08 mg in OC, which could be the result of processing or absorption by other components. A slight reduction in zinc (Zn) is observed in mayonnaise (1.2 mg) compared to OC (1.56 mg), probably due to dilution by other ingredients. Selenium (Se) is significantly reduced in mayonnaise at 17.9 µg compared to OC which contains 40 µg, which could be due to processing or the nature of the added ingredients. The results of the processing of the basic ingredients of mayonnaise show us that minerals such as sodium, iodine, and iron are significantly more concentrated in mayonnaise, due to the addition of salt, iodized ingredients, and other additives; and, minerals such as potassium, magnesium, calcium, phosphorus, copper, zinc, and selenium are reduced in mayonnaise, which could be due to dilution or losses during processing (Table 5).

According to the analysis of the physicochemical characteristics, quail eggs have a dry matter content of 25.3%, indicating that about a quarter of their mass is solids (proteins, lipids, etc.), while the rest is water. The dry matter in HPC is extremely high at 98.9%, which is expected for oils and other non-aqueous products. As for mayonnaise, it has a dry matter content of 87.47% (Tables 2 and 6), which is high but logical given that it contains a large amount of oil (which is essentially dry matter). The dry matter of HPC is almost entirely solids (oil), which is consistent with their nature; quail eggs have a more balanced composition between water and solids, with a high proportion of water and mayonnaise, although more concentrated in solids than eggs, remains below the HPC, since it still contains a proportion of water. Moisture in HPC is very low (1.1%), which is typical for oils and other products with low water content. Quail eggs are composed of 74.7% water, which is expected for fresh eggs, indicating their high water content. Mayonnaise contains 12.53% water, which is low but understandable given the high oil content. The pH of quail eggs is 6.87, which is slightly acidic, close to neutral. On the other hand, mayonnaise has a pH of 4.5, which is more acidic. This is expected due to the addition of vinegar or lemon during the preparation of mayonnaise. After analysis, we find that

**Table 5 Comparative mineral composition of mayonnaise and its manufacturing ingredients.**

| Minerals | Units | HPC | OC | Mayonnaise |
|---|---|---|---|---|
| Na | mg | - | 152 ± 1.27 | 530 ± 3.52 |
| K | mg | - | 145 ± 1.16 | 60 ± 0.27 |
| Mg | mg | - | 15 ± 0.12 | 5.09 ± 0.02 |
| Ca | mg | - | 67 ± 0.31 | 38 ± 0.11 |
| P | mg | - | 250 ± 1.45 | 122.2 ± 1.06 |
| I2 | µg % | - | 18 ± 0.34 | 36.08 ± 0.25 |
| Fe | mg | - | 3.71 ± 0.03 | 21 ± 0.08 |
| Cu | mg | - | 0.08 ± 0.001 | 0.03 ± 0.002 |
| Zn | mg | - | 1.56 ± 0.003 | 1.2 ± 0.004 |
| Se | µg | - | 40 ± 0.07 | 17.9 ± 0.08 |

**Table 6 Physicochemical characteristics of quail eggs.**

| Characteristic parameter | HPC | OC | Mayonnaise |
|---|---|---|---|
| Dry matter | 98.9 ± 0.35 | 25.3 ± 0.07 | 87.47 ± 0.23 |
| Humidity | 1.1 ± 0.002 | 74.7 ± 0.22 | 12.53 ± 0.12 |
| pH | | 6.87 ± 0.07 | 4.5 ± 0.09 |

**Table 7 Physical chemical characteristics of PSO.**

| Features | Units | Values |
|---|---|---|
| Color | - | Yellowish |
| Density | $kg/m^3$ | 0.922 ± 0.004 |
| Refractive index | ND | 1.464 ± 0.003 |
| Acidity index | mg/1 g | 0.163 ± 0.002 |
| Iodine index | g/100 g | 89.707 ± 0.08 |
| Saponification index | mg/1 g | 12.806 ± 0.07 |

the physicochemical characteristics of quail egg show a balance between dry matter and moisture, with a slightly acidic pH. In contrast, mayonnaise, although derived from eggs, has a higher dry matter content, lower moisture, and a more acidic pH, due to added ingredients such as oil and vinegar. Oils and related products (HPC) show very low moisture and almost total dry matter, characteristic of their nature.

In Table 7, the physicochemical characteristics of PSO indicate a yellowish color, which can vary from yellow to dark green depending on the extraction method and the degree of refining. This color indicates that the oil contains natural pigments, such as carotenoids. The density with a value of 0.922 ± 0.004 $kg/m^3$ of PSO is slightly lower than that of water, which is normal for vegetable oils, which usually have densities between 0.91 and 0.93 $kg/m^3$. This means that PSO is relatively light, and this property is important for food and cosmetic applications. A refractive index value of 1.464 indicates that the PSO has an optical structure typical of vegetable oils, which is usually between 1.46 and 1.47. This can also give an indication of the purity of the oil and the absence of blends with other oils. A value of 0.163 mg/g for the acidity value is relatively low, indicating that the PSO is of good quality, with low free fatty acids. This is important for the stability of the oil, as low acidity suggests better resistance to oxidation and a longer shelf life. A value of 0.163 mg/g is relatively low, indicating that the PSO is of good quality, with low free fatty acids. This is important for the stability of the oil, as low acidity suggests better resistance to oxidation and a longer shelf life. A value of 12.806 mg/g is relatively low for a vegetable oil, suggesting that PSO contains primarily long-chain triglycerides. This may be favorable for some cosmetic applications where a less reactive oil is desired.

The results of the tasting protocol of a panel of 10 tasters for diet mayonnaise (Table 8) gave the following remarks:

(1) Appearance (Total: 74, Rank: 4)

With a total score of 74 points, the appearance is judged quite favorably by the tasters, although this criterion is ranked 4th among the five criteria evaluated. This indicates that, although the appearance is satisfactory, there could be room for improvement to make the product more visually appealing.

(2) Smell (Total: 75, Rank: 3)

Smell gets a total score of 75 points and ranks 3rd. This suggests that the smell of diet mayonnaise is liked, but not at the level of the best characteristics. Smell is important to the overall perception of the product, and although it is judged positive, it is not exceptional.

(3) Color (Total: 76, Rank: 2)

The color is well rated, with a total of 76 points and occupies a 2nd place in the ranking of the criteria. This shows that the color of the diet mayonnaise is well accepted by the tasters, and that it contributes positively to the visual appeal of the product.

**Table 8 Results of the tasting protocol of the panel of 10 tasters.**

| Tasters | Appearance | Smell | Flavor | Color | Texture |
|---|---|---|---|---|---|
| 1 | 6 | 7 | 7 | 8 | 7 |
| 2 | 6 | 6 | 6 | 6 | 7 |
| 3 | 6 | 6 | 7 | 7 | 8 |
| 4 | 7 | 7 | 7 | 7 | 7 |
| 5 | 8 | 8 | 7 | 7 | 8 |
| 6 | 8 | 8 | 8 | 8 | 8 |
| 7 | 9 | 9 | 8 | 9 | 9 |
| 8 | 7 | 7 | 7 | 8 | 9 |
| 9 | 8 | 9 | 8 | 9 | 9 |
| 10 | 9 | 8 | 7 | 7 | 8 |
| Total | 74 | 75 | 72 | 76 | 80 |
| Rank | 4 | 3 | 5 | 2 | 1 |

(4) Texture (Total: 80, Rank: 1)

Texture is the highest rated characteristic, with a total score of 80 points, and is ranked 1st. This means that the diet mayonnaise has a texture that is very pleasing to tasters, probably being creamy and pleasant in the mouth. Texture seems to be a strong point of the product, and this quality could be a major asset for its marketing. In sum, the texture and color of the diet mayonnaise are its strong points, being well appreciated by tasters. The good texture in particular can be a key success factor for this product. The appearance and smell, although satisfactory, could still be optimized to improve the overall appeal of the product. However, flavor is the most concerning criterion, as it is essential for overall consumer satisfaction. Adjustments could be necessary to improve the taste profile of the diet mayonnaise. As a result, although the diet mayonnaise is generally well received, targeted improvements on flavor, and possibly on visual appearance, could strengthen its acceptability and success in the market.

## 4. Discussion

The chemical compositions of the base materials and mayonnaise are shown in Table 3. PSO is an anhydrous product. It contains less water, i.e. 1.1 g%. It is also not a source of protein, i.e. 0.7 g%, nor does it contain carbohydrates. It is essentially formed of fat, i.e. 98 g% of its total mass. Saturated fatty acids occupy almost only 1/5 of its mass. Monounsaturated fatty acids make up ¼, i.e. 26 mg% of the total. Polyunsaturated fatty acids, including linoleic acid and oleic acid, occupy more than half of the total fatty acids, i.e. 52 mg%. The content of PSO in phytosterols (similar structure to cholesterol) whose property is to reduce the absorption of blood cholesterol at its receptors is worth almost 1/3 of the recommended requirements of adults, i.e. 106 mg% compared to 300 mg [15, 16]. PSO provides nearly 900 kcal or 887 kcal%g (Table 2). PSO is an important source of vitamins. It contains them at a dose of 3.5 mg%g (Table 4). Quail eggs contain nearly 75% water, or 74.7% (Table 6). Like chicken eggs, they contain an average of 12 g%g, or 12.5 g%g. Lipids occupy more than 10%, or 11.1 g%g of the total mass. In quail eggs, saturated fatty acids only account for 3.45 mg%g (Table 2). As for monounsaturated fatty acids, they occupy the largest fraction of fatty acids, or 4.55 mg%g (Table 2). As for polyunsaturated fatty acids, their content is estimated at 1.28 mg%g. The cholesterol in quail eggs is quite considerable, with a content of 836 mg%g (Table 2). Quail eggs are one of the rare animal products to contain sugars. It contains less than 1 g% or 0.45 g%g. Quail egg is an important source of water-soluble and fat-soluble vitamins. The tanners of water-soluble vitamins B1, B2, B3, B5, B6, B7, B8, B9, and B12 are respectively 0.15 mg%, 0.83 mg%, 0.17 mg%, 1.82 mg%, 0.18 mg%, 15.4 mg%, 20.6 mg%, 0.72 mg% and 1.65 µg%. The respective contents of fat-soluble vitamins A, D, E and K are: 162.3 µg%, 1.54 µg%, 1.12 mg% and 0.41 µg% (Table 4). Quail eggs are also an important source of major minerals (sodium, potassium, magnesium, calcium and phosphorus) with respective contents of 152 mg%, 145 mg%, 15 mg%, 67 mg% and 250 mg%. The contents of trace elements present in quail eggs are 36 µg% of iodine, 3.71 mg% of iron, 0.08 mg% of copper, 1.56 mg% of zinc and 40 mg% of selenium. Mayonnaise is a sauce essentially composed of oil and eggs, from which it benefits from the advantageous properties. Vegetable oil contains unsaturated fatty acids (omega 3, omega 6) useful for protecting the heart and blood vessels. Eggs provide a great source of proteins and lipids. From a formulation point of view, PSO is the major constituent of mayonnaise with a proportion of 38%. It is supported by diluent which occupies 36.78%. The essential ingredient is the emulsifier, egg yolk (10% of the total weight) which thanks to lecithin the mayonnaise acquires the desired consistency. Mustard (mustum ardens, from the Brassicaceae family), enters the formulation at a dose of more than 2% or 2.2%. The aqueous extract of mustard, together with lemon juice at a concentration of 0.2 g% keeps the oil droplets in suspension which then makes the mixture firm and homogeneous. In view of its composition, mayonnaise contains less than 15 g% of water or 12.5 g%. Its protein content is 3.41 g%. The lipids mainly present in mayonnaise occupy 82.53 g% of its mass. The fatty acids, saturated, monounsaturated and polyunsaturated provided by the lipids of its two major constituents, PSO and quail egg, are respectively 5.54, 45.28 and 7.44 mg%. The cholesterol level in mayonnaise is 245.22 mg%, which is almost the recommended requirements for an adult (300 mg per person per day). Carbohydrates and fibers are in infinite fractions in mayonnaise. The energy intake of mayonnaise is estimated at 750 kcal/100 g (Table 2). The fatty acids measured in PSO, quail egg oil and mayonnaise (Table 3) are palmitic and stearic acids as saturated fatty acids, oleic acid as monounsaturated fatty acids and linoleic, linolenic and G-linolenic acids as polyunsaturated fatty acids. Overall, they are more present in PSO which contains 16.84 mg% palmitic acid, 7.8 mg% stearic acid, 5.6 mg% oleic acid, 36.95 mg% linoleic acid, 7.5 mg% linolenic acid and 40.47 mg% G-linolenic acid. Quail egg succeeds with 8.57 mg% of palmitic acid, 4.3 mg% of stearic acid, 16.4 mg% of oleic acid, 3.8 mg% of linoleic acid, 5.7 mg% of linolenic acid and 1.3 mg% of G-linolenic acid (Table 3). Mayonnaise is a concentrate of water-soluble and fat-soluble vitamins (Table 4). Its water-soluble vitamin contents are 0.06 mg% for vitamin B1, 0.1 mg% for vitamin B2, 0.021 mg% for vitamin B3, 2.61 mg% for vitamin B5, 0.081 mg% for vitamin B6, 17.91 mg% for vitamin B7, 12.21 mg% for vitamin B8, 1 mg% for vitamin B9, and 1.521 mg% for vitamin B12. Its fat-soluble vitamin tanners are 10.81 µg% for vitamin A, 1.241 µg% for vitamin D, 2.31 mg% for vitamin E and 0.1021 µg% for vitamin K. The contents of mayonnaise in major minerals Na, K, Mg, Ca, P (Table 5), are respectively 530 mg%, 60 mg%, 5.09 mg%, 38 mg% and 122.2 mg. The contents of trace elements I, Fe, Cu, Zn and Se are respectively: 3,508 mg%, 21 mg%, 0.03 mg%, 1.2 mg% and 17.9 µg%. The average dry matter content (Table 6) in PSO, quail egg and mayonnaise are 98.9 g%, 25.3 g% and 87.47 g% respectively. This corresponds to the average moisture content of 1.1 g%, 74.7 g% and 12.53 g% respectively. The pH values of PSO, quail egg and mayonnaise are 5.4, 6.8 and 4.5. However, the pH value found (4.5) would be slightly higher than the values of a range of mayonnaise prepared (3.20-3.25) by Nesrine [17] with a difference of at least 1.25. The physical and chemical parameters of PSO are shown in Table 7. As a result, the color is yellowish. As for the density, the refractive index, acid, iodine and saponification indices are respectively 0.92 kg/m$^3$, 1.464, 0.163 mg/g, 89.207 g/100 g and 12.806 mg/g. The organoleptic indices (Table 8) of our cold sauce evaluated by the ten tasters were the appearance, the odor, the flavor, the color and the texture. Three (3) of the 10 tasters describe the appearance as fairly good, 2 consider it good, 2 attest to it as very and for 2 of them this index is excellent. On average, the appearance of the cold sauce is good. The smell is estimated as fairly good for 2, good for 3, very good for 3 and excellent for 3 which gives an average of 7.5 qualifying the smell as good. The flavor is rated quite good by 1, good by 6 and very good by 3, which qualifies the index as good with an average of 7.2. The assessments on the color are quite good for 2, good for 4, very good for 2 and excellent for 1 only. This corresponds to an average of 7.6/10 and ranks 2nd in the organoleptic indices. The texture was ranked 1st in the organoleptic indices for an average of 7.8/10 points, following the tasters' assessments including good for 3, very good for 4 and excellent for 3.

## 5. Conclusion

Considering the biochemical composition of the formulated cold sauce (macronutrients, saturated and unsaturated fatty acids, vitamins, major minerals and trace elements), the results of this study show that PSO, due to its richness in nutrients and its antioxidant properties, is a promising ingredient for the formulation of dietetic sauces. The use of a cold-pressed extraction method is recommended to maximize the nutritional and sensory quality of the oil. The association with quail eggs in a cold sauce makes it possible to obtain a balanced final product, both tasty and beneficial for health. These results also suggest that PSO could be further explored in other culinary or dietary applications, particularly in the context of diets aimed at improving cardiovascular health.

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