Muffins and cookies produced from chickpea Flour

Ines C. Gonzales, Hilda L. Quindara, Fernando R. Gonzales
and Esther T. Botangen

Abstract

Chickpea (*Cicerarietanum* L.) is a newly introduced crop in the Philippines particularly in Benguet. It is a cool season crop and initial results showed that higher yield was obtained under Benguet conditions which ranged from 800-1,200 kg/ha. It has high protein content and dietary fiber.

Pre-treatment techniques for grits production has been identified to improve the acceptability of chickpea substituted muffins and cookies.
Fermenting chickpea seeds in solution with lactic acid bacteria and boiling chickpea seeds for 10 minutes reduces beany flavor of chickpea grits. Likewise, grits from fermented chickpea seeds had smooth, elastic, fine and soft dough characteristics for the production of cookies and muffins. Chickpea grits were substituted at 40% for cookies. Acceptable substitution rate for muffins is 30%. Nutritionally, the substituted products contain considerable amount of energy, protein and carbohydrate.

Keywords: aerobic count, grits, lactic acid bacteria, milling steam, roasted

1 INTRODUCTION

Chickpea is a good source of minerals, protein and trace elements. Legumes contain almost 2 times more protein and minerals and 3 times more in dietary fiber than wheat flour (Sath et. al, 1984). Legume proteins are rich in lysine which is an important essential amino acid limited in cereal grains (Muller, 1983). Its anti-nutritional factor is the lowest of all legumes.
At present, the supply of chickpea depends mainly on importation from India, Pakistan, Iran, Mexico, Australia and Canada. To help reduce importation, Chickpea production is being introduced in the Philippines. Initial results shows that the yield potential of 800 – 1200 kg/ ha is higher than the average global production of 700 – 800 kg/ ha. Such findings imply that chickpea can be grown under Philippine conditions which can serve as an alternative high value crop for farmers.
In a technological feasibility of incorporating legume flours (35 %) for pasta making, nutritional analysis showed that the dough contains high levels of fiber, vitamin B1, magnesium, phosphorous, protein, good balance of essential amino acids. Its glyceamic index is also lower than that of durum wheat dough. Lowered glyceamic index as a result adding legume flour is a positive characteristic of a wheat- legume food product.
Utilization of the crop is limited to " igado", kaldereta" and *halo-halo*. Product development aims to explore alternative utilization techniques for the crop thereby increasing its product line in the market. Product development can promote production, utilization, and marketing of the crop.
This project can help enhance alternative livelihood opportunities to farming households, reduce dollar drain and provide alternative nutritious and health promoting food products in the market.

2 General Objectives:

Develop suitable processing techniques for chickpea processed snack food products

Specific:

1. Identify processing techniques to improve the functional properties and quality of chickpea substituted food products;
2. Develop organoleptically acceptable chickpea-wheat muffins and cookies
3. Evaluate nutritional content and microbial quality of chickpea grits substituted muffin and cookies.

3 Review of Literature

3.1 Nutritional value and health benefits obtain from chickpea

Chickpea is an Asiatic herb cultivated for its short pod with one or two edible seeds. It is the most important food legume grown globally. It is valued for its nutritious seeds because of its high protein (25.3–28.9%), total carbohydrates (64%), and dietary fiber (19%). It also contains considerable amounts of phosphorous, calcium, magnesium, copper and zinc. It is low in fat and most of the fat content is the poly-unsaturated type.
The concentration of unavailable carbohydrate in chickpea is the highest among Indian pulses (William & Singh,1987). Chickpea contains oligosaccharide that belongs to the raffinose family. The monogastrics cannot metabolize oligosaccharide so it passes thru the colon where it is fermented to produce carbon dioxide and methane. Although it causes abdominal discomfort, oligosaccaharide plays a role in osmotic regulation which can be beneficial in maintaining flora that help prevent colonic cancer.
Legume starches are slowly digested (Mwangwela&Minnaar, 2001, Micard (2004) reported that incorporating 35% of legume flour in pasta had improved the nutritional content and decreased the glyceamic index of starch.

3.2 Functional Properties of legume flours and its influence on processing and qualities of food products

Legume flour such as chickpea contains proteins and starch that influence the utilization and qualities of food products. Proteins are usually linked to solubility, water absorption, binding, viscosity, gelation, cohesion-adhesion, fat absorption, flavor binding, foaming and color control (Waters, 1990). Starch on the other hand is associated to swelling, solubility, water absorption, viscosity, gelation, and gelatinization.
Water absorption capacity is an important functional characteristic in the development of ready to eat products from cereals because high water absorption capacity may assure product cohesiveness (Flemin et. al, 1974). Relatively high carbohydrate content contributes to high water absorption capacity.
Lentel, faba and field peas starches have high water binding capacity (92.4–98 %) which is comparable to wheat starches. The emulsion capacity of chickpea flour is 2–3 times higher than wheat flour (Lyer& Singh, 1997). Hence, the addition of chickpea flour to wheat flour may not influence dough properties but enhance stability because of the higher emulsion capacity of chickpea flour (Bhatty, 1988).
For deep fried products, addition of chickpea flour had greatly reduced oil absorption due to the chemical and physical nature of proteins (Lyer, 1997).

Processing techniques employed for legume flour production

Several methods are applied for legume flour production. To reduce beany flavor of cowpea flour, preliminary steaming is recommended prior dry roasting and milling (Phillips, 2003, Sales 1987). On the other hand, sprouting and toasting seeds of cowpea prior to milling helped reduce beany flavor and help modify the functional properties of the legume flour so that the baked products does not have a hard texture (Hallen, et, al, 2004). Soaking seeds of cowpea in acidified water solution flowed by blanching reduced beany flavor and produced highly acceptable loaf volume at 10 % substitution (Okaka& Potter, 2001).
The use of cowpea flour made from non-decorticated (non-removal of seed coat) produced bread which was similar in quality to all wheat flour. However, increasing the level of substitution to 15 & 20 % produced breads with noticeable black specks, with beany flavor and compact texture (Mustafa, 1990).
Dehulling consists of two steps: removal of seed coat and splitting of cotyledons. In India soaking in water for 2 – 14 hours followed by sun drying is a common practice before dehulling. Pre-heating seeds at a higher temperature also help loosen seed coat and increase dhal yield (Knight, 2000).
Adaptability trials have shown that the Philippines can produce the Desi type chickpea which is well suited for processing into soups and breads. The crop has a wide range of adaptability from lowland to mid-lowland elevations and can grow better under drought conditions. Hence, an excellent alternative crop during drought conditions.
Preliminary studies indicated that chickpea grits can be utilized into puto and cookies (BSU-PCIEERD, 2009). However, sensory results showed that the product acceptability is moderate to low because of the perceived beany flavor, hard and compact structure of the products.
To enhance the acceptability of chickpea substituted food products, there's a need to improve the qualities (functional and flavor) of chickpea grits.
Legumes contain unsaturated lipids that are susceptible to oxidation deterioration. Enzymatic and non-enzymatic deterioration of these lipids results in development of off-flavors. There are several techniques recommended and /or employed to inhibit formation of off-flavor and improve the functional properties of legume flours. These methods include germination, fermentation, acidification, blanching in hot water, steaming and roasting.
Aside from inhibiting off-flavor formation, processing methods influences nutritional and functional properties of legume flours. Germination improves amino acid availability, increase availability of vitamins, decrease concentration of phytic acid and trypsin inhibitors (David & Verna, 1981). Fermentation solubilizes protein, inactivate anti-nutritional compounds and increase water soluble vitamins.
Hence, processing treatments for chickpea grits production need to be standardized to improve the flavor, functional properties and nutritive value of chick pea grits.

4 Methodology

4.1 Product development of chickpea grits into muffins and cookies

Chickpea grits that exhibit acceptable qualities (less or no beany flavor) was developed into muffins and cookies. Using a recipe for muffins, wheat flour was substituted from 0, 10, 20, and 30 %.
Optimum formulation was identified based on results of sensory evaluation. Sensory evaluation was based on color, appearance, texture, lightness, tenderness, flavor and general acceptability. There were fourty (40) panelists.
A very desirable muffin has the following characteristics: golden brown and symmetrical exterior; rounded top with pebbled surface; creamy white; slightly moist interior; fairly uniform cells and moderately thin cell walls. These desirable characteristics were used in formulating the score cards for muffins.
For cookies, sensory evaluation were based on the appearance, volume, texture and flavor and general acceptability using hedonic 1 to 9 rating scale (1-dislike extremely- 9-like extremely).

Sensory data were analyzed using the analysis of variance. DMRT was used to locate the significant differences among means of the different chickpea- wheat combinations.

4.2 Nutritional content of chickpea based food products

Based on results of sensory evaluation, a potential processing technique or formulation was established. The chickpea substituted product was submitted to FNRI-DOST for proximate analysis.

5 Results and Discussions

5.1 Evaluation of pre-processing techniques to improve quality of chickpea

Milling and Grits Characteristics

Chickpea seeds soaked in lactic acid fermented milk (yakult or yogurt) had soft and easy milling characteristics. Grits also had slight beany odor with smooth and elastic handling characteristics. Good dough handling characteristics can be attributed

to the finer and soft textural characteristics of grits.
Soaked-oven dried seeds had moderate milling and the dough had soft and sticky handling characteristics. Soaking seeds did not reduce the beany flavor of grits.
Roasted seeds were hard to mill and the resulting grits had moderate beany odor. Grits which were steamed followed by roasting had smooth and elastic dough handling characteristics while grits from seeds that were boiled then roasted had soft and sticky dough characteristics.
Pre-sprouted seeds had moderate milling characteristics and beany odor but the dough tends to be dry and inclined to be lumpy. Hence, not suited for preparing breads.

Table 1. The milling and dough characteristics of chickpea grits

	CHARACTERISTICS		
Treatment	Milling	Beany odor	Dough Handling
Pre-sprouted	Moderate	Moderate	Dry, hard and inclined to be lumpy
Soaked- oven dried	Moderate	Very pronounced	Soft and sticky
Steam roasted	Hard	Moderate	Smooth and elastic
Boiled roasted	Hard	Moderate	Soft and sticky
Fermented (lactic acid)	**Soft and easy**	**Slight**	**Smooth and elastic**

5.2 Influence of the different pre-treatment techniques on the sensory characteristics of wheat-chickpea cookies (40 % substitution rate)

Cookies made from grits which were soaked then oven- dried had the lowest acceptability rating of 1.8 (unacceptable – poor) which can be attributed to the beany flavor of the product. Highest acceptability rating of 4.5 (like a lot – dislike a lot) was obtained from fermented grits followed by boiled and toasted grits.Grits which were pre-sprouted and steam-toasted prior to milling had poor texture (more resistance when bitten). Grits processed by boiling then toasting and fermenting in lactic acid gave better texture (little resistance to bite).

The different pre-treatment techniques did not influence significantly the appearance of cookies. However, the highest rating for appearance was gathered from fermented grits (4.5) closely followed by boiled and toasted grits.

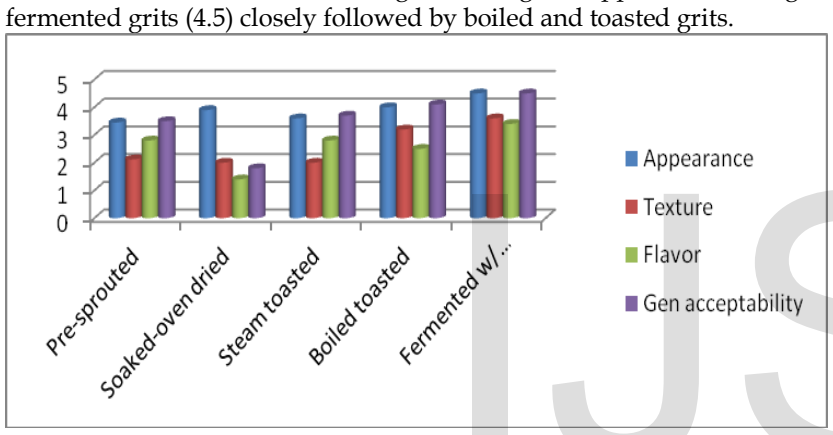

Fig. 1. Sensory characteristics of cookies substituted with pre- treated chickpea grits

5.3 Influence of the different pre-treatment techniques on the sensory qualities and acceptability of wheat – chickpea muffins

Significant differences among treatments were observed (Fig 2 &3). The acceptability rating (3.7) however is quite low at 40% substitution rate. To improve the quality and acceptability of chickpea muffins, the substitution rate was lowered from 40 to 30 %.

At 30 % substitution rate there was an improvement in the acceptability rating.

Results showed that muffins from grits on fermented lactic acid had the highest acceptability rating which is comparable with those from boiled then roasted. Muffins from this treatment had moderately thin cell walls with fairly uniform cells.

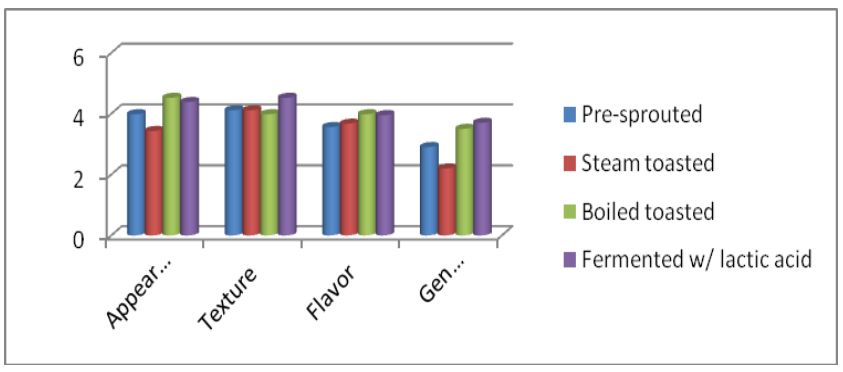

Fig 2. The influence of the different pre-treatment techniques on the sensory qualities and acceptability of wheat-chickpea muffins (40%)

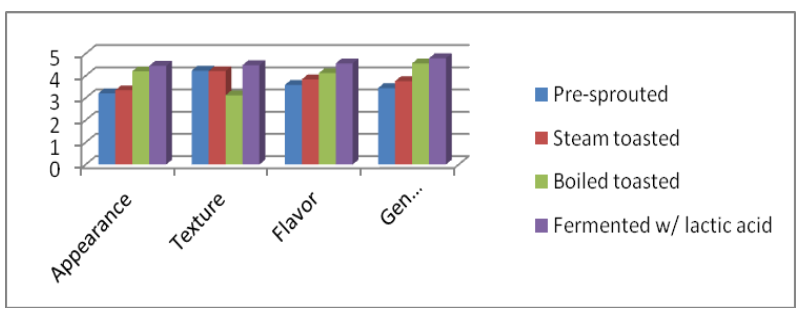

Figure 3. The influence of the different pre-treatment techniques on the sensory quality and acceptability of wheat-chickpea muffins (30 %)

5.4 Nutritional content of chickpea flour compared to wheat flour

Chickpea flour was analyzed by Food Nutrition Research Institute (FNRI) and Industry and Trade Development Institute (ITDI) - Department of Science and Technology (DOST) for its protein, fiber, carbohydrate, iron and fat content. Results showed that dietary fiber, protein, iron and fat content of chickpea flour was higher compared to wheat flour (Fig 4&5). Dietary fiber of chickpea flour was 13.7g while 0.4g for wheat flour. Protein content for chickpea flour had 19.2g while 11.0g for wheat flour. Iron of chickpea flour was 12.0mg while 4.1mg for wheat flour. Total fat of chickpea flour had 10.4g while wheat flour had 3.6g. Ash for chickpea flour was 2.7g and wheat flour with 0.4g.Carbohydrates, energy, and moisture was higher on wheat flour than on chickpea flour. Carbohydrate of wheat flour was 75.2g while chickpea flour had 369.4g. Energy of wheat flour was 377 kcal while chickpea flour had 358 kcal. Moisture was 9.8g for wheat flour and 8.3g for chickpea flour.Protein content of chickpea flour coincides with earlier literatures that it contains higher crude protein as compared to wheat flour. Jambunathan and Singh, 1981 also made mention that chickpea flour contains 25-28% and more than 70% of chickpea is used for making dhal and processed into flour (besan).

With these results it shows that substitution of chickpea flour can improve the nutritional quality on dietary fiber, protein and iron of bakery products. This substitution can therefore help reducing malnutrition problems.

Dietary fiber is an essential part of a healthy diet, it is best for its ability to prevent or relieve constipation, lowering risk of diabetes, heart disease, lower blood cholesterol, glucose levels, and prevents colon cancer (dietary fiber, http//www.com health).

Proteins are involved in all cell functions. Some proteins involved in structural support while others in bodily movement or in defense against germs. Hormonal proteins are messenger proteins which help to coordinate certain body activities. Example insulin, oxytocin and somatotropen. Insulin regulates glucose metabolism by controlling blood sugar concentration. Oxytocin stimulates contractions in female childbirth. Somatotropin is a growth hormone that stimulates protein production in muscle cells (http://biology/protein function).

Iron is a trace mineral to the body. It helps in the formation of red blood cells and helps carry oxygen from the lungs to the body tissues.

Table 2. Nutritional content of chickpea flour compared to wheat flour (All purpose flour)

Nutrients Analyzed per 100 gm	Chickpea flour (ICCV-93954)	Wheat flour (All purpose flour)
Moisture, g	8.3	9.8(13.2)
Ash, g	2.7	0.4(5.4)
Energy, kcal	358(356)	377(455)
Total fat, g	10.4(0.6)	3.6(1.2)
Total Carbohydrate, g	69.4(53.2)	75.2(92.8)
Dietary Fiber, g	**13.7(9.9)**	0.4(3.4)
Protein, g	**19.2(20.6**)	11.0(12.4)
Iron (Fe) mg	**12.0**(4.5)	4.1(5.8)

Analyzed by FNRI/ITDI-DOST
In parenthesis was sourced: http/chickpea flour/wheat flour

5.5 Nutritional content of chickpea cookies and muffins as affected by pre-treatment methods

Boiling chickpea seeds followed by toasting and fermenting in lactic acid bacteria had almost similar nutritional content (Table 7). Wheat – chickpea cookies contains 500 calories, 8 - 9 g of protein, 23 – 24 g fat, and 64 – 65 g carbohydrate.

For muffins, a serving size of 36 g contains 125 – 130 calories, 3 g of protein, 6 g of fat, 15 -16 g carbohydrate and 72 -77 of sodium.

Table 3. The nutritional content of wheat-chickpea cookies and muffins as affected by pre treatment methods

	COOKIES (60 g serving size)		MUFFINS (36g serving size)	
Nutrient	Boiled-toasted	Fermented	Boiled-toasted	Fermented
Energy, cal	300	300	130	125
Protein, g	5	5	3	3
Fat, g	14	14	6	6
Carbohydrate, g	39	38	16	15
Sodium, mg	140	140	72	77

6 Summary and Conclusion

Beany flavor of legumes is one of the factors that influence the quality as well as acceptability of legume products. To reduce beany flavor of grits, several pre-treatment techniques and its influence on the functional properties and nutritional quality has been evaluated.
The pre-treatment techniques had significantly influenced the beany flavor of chickpea grits. Soaking followed by oven drying was not effective in reducing the beany odor of grits. Pre-sprouting, boiling, toasting and fermenting in lactic acid bacteria were more effective in reducing the beany characteristics of chickpea grits.
Fermenting chickpea seeds prior to milling produced the most acceptable cookies

and muffins. Acceptable muffins are prepared from 30% level of substitution. Chickpea substituted cookies and muffins are nutri-packed safe products. A 60g pack of cookies contains 300cal, 39g carbohydrate, 5g protein and 140g sodium. On the other hand, a 36g muffin contains 125-135 calories, 15g carbohydrate, 3g protein and 72–77g sodium.

7 Recommendation

To reduce beany odor characteristics of chickpea grits pre-treatment of chick pea seeds in lactic acid bacteria fermentation and boiled, toasted is recommended.

Chickpea grits with 30-40% substitution of wheat flour for cookies and muffins is recommended for a nutritious safe product.

8 References

[1] Knight, R. 2000. Linking research and market opportunities for pulses in the 21th century.

[2] Frias, T. A., Granito, M., Vidal-Valverde, C. 2006. Fermented pigeon pea (*Cajanuscajan*) ingredients in pasta products. Journal Agricultural Food Chemistry. 2006, Sept. 6 (54)(18):668591

[3] Hallen, E., Ibanglu, S., Ainswork, P. 2004. Journal Food Engineering.63, 177- 184.

[4] Mc Watters, K. H. 1986. Use of peanut and cowpea flour in selected fried and baked products. Plant Protection: Application, Biological Effect & Chemistry. Copyright 1986.American Chemical Society.

[5] Mc Waters, K. H. 1990. Functional Characteristics of Cowpea flours in food. JAOCS, Vol.67 # 5.

[6] Okaka, J. C.& Potter, N. N. 1979. Sensory, nutritional and storage properties of cowpea powder processed to reduce beany flavor. Journal of Food Science.Vol 44.Issue # 5.

[7] Okpala, L. S. &Mamali, E. N. 2001. Functional properties of raw and processed pigeon pea.International Journal of Food Science & Nutrition 1465- 3478 Vol. 52.

[8] Onimawo, J. A., Akpowwo, A. E. 2010. Toasting (dry heat) & nutritional composition, functional properties and anti-nutritional factors of pigeon pea. Journal of Food Processing & preservation.Vol 30 Issue 6.

[9] Onweluzo, J. C. &Nubugwu, C. C. 2009. Fermentation of millet & pigeon pea seeds for flour production: Effect on Composition and selected functional properties. Pakistan Journal of Nutrition.Vol.8. Issue 6.

[10] Onwuka, G. I. 2001. Soaking, boiling and anti-nutritional factors in pigeon pea and cowpea.Journal of Food Processing and Preservation.Vol 30.Issue # 5.

[11] Pyler,T.1971. Water content influences storage stability of wheat flour. Baking Science & Technology.pp.548.Chicago.

[12] Shahzadi,N., Masood S., Sallem UR Rehmann and Karan Sharif.2005.Chemical characteristics of various composite flours. International Journal of Agriculture & Biology.1560-8530/2005/07-1-105-108.

9 Acknowledgement:

The authors would like to express their gratitude to the following agencies:

- PCIEERD-DOST for providing financial assistance,
- CIERDEC–CAR for technical improvement of the proposal,
- FNRI-DOST for the analysis of the products,
- ICRISAT for initial seeds,
- DOST-CAR for moral support
- BSU staffs involved with the project
- ASEAN Food Conference for accepting our paper

Without them this endeavor would not be a success. We thank them all.

[1] or dissertation)

[2] E.E. Reber, R.L. Michell, and C.J. Carter, "Oxygen Absorption in the Earth's Atmosphere," Technical Report TR-0200 (420-46)-3, Aerospace Corp., Los Angeles, Calif., Nov. 1988. (Technical report with report number)

[3] L. Hubert and P. Arabie, "Comparing Partitions," *J. Classification,* vol. 2, no. 4, pp. 193-218, Apr. 1985. (Journal or magazine citation)

[4] R.J. Vidmar, "On the Use of Atmospheric Plasmas as Electromagnetic Reflectors," *IEEE Trans. Plasma Science*, vol. 21, no. 3, pp. 876-880, available at http://www.halcyon.com/pub/journals/21ps03-vidmar, Aug. 1992. (URL for Transaction, journal, or magzine)

[5] J.M.P. Martinez, R.B. Llavori, M.J.A. Cabo, and T.B. Pedersen, "Integrating Data Warehouses with Web Data: A Survey," *IEEE Trans. Knowledge and Data Eng.*, preprint, 21 Dec. 2007, doi:10.1109/TKDE.2007.190746.(PrePrint)