J Krishi Vigyan 2017, 5(2) : 15-21 DOI : 10.5958/2349-4433.2017.00004.6

Comparative Evaluation of Different Attributes of the Existing Extruded Snacks

Jagbir Rehal[1], GaganJyot Kaur[2], Amarjeet Kaur1and AKSingh[3]

Department of Food Science and Technology
Punjab Agricultural University, Ludhiana 141 004 (Punjab)

ABSTRACT

The different brands of extruded products consumed as snacks were surveyed in the local market and were compared for their listed nutritional status along with textural and functional properties. The snacks were constituted mainly of wheat and maize as well as rice, potato, and grams, soy and pulses. The price of the snacks varied from Rs.147/- to Rs.2000/-kg. The average content of energy, carbohydrates, protein and fat for extruded snacks were 489.34kcal/100g, 22.73, 46.53 and 6.97 percent,respectively. The bulk density varied between 107.69 to 763.64 kg/m3. This information will help to guide the entrepreneurs for product development which is nutritious and made with cheaper source, according to the need and preference of the consumers.

Key Words: Extrusion, Extruded Snack, Physical, Functional properties.

INTRODUCTION

Extrusion cooking is a high temperature and shear process that is characterized by forming a melt from the starchy ingredient, at high temperature (140–180°C), low moisture content (12%) and low mean residence time of 15–30s. Cereal grains mainly rice, wheat and corn with different physico-chemical characteristics are used as major raw materials in extruded snack foods and breakfast cereals due to their good expansion characteristics. Starch is the main constituent responsible for the structural attributes of the extruded products. A large variety of extruded Ready-to-eat (RTE) snacks are available in the market. Direct-puffed snacks made by extrusion process are classified as a second-generation snack. They are usually low in bulk density and are often marketed as high-fiber, low-calorie, high-protein and nutritional product (Liu *et al*,2000). Crisp extruded snacks are widely consumed convenience food products. These snacks are dense in energy but are nutritionally poor and it is possible to add beneficial nutrients. Although the nutritional properties are important, the consumer acceptability of the snacks depends mainly on the physical and organoleptic properties of the snacks. Physical characteristics of extruded products such as expansion, hardness and density are important parameters along with its functional properties (Jamora *et al*, 2002) whereas texture is also considered as one of the most important factors (Mazumder *et al*, 2007). There is an increasing consumer demand for more complex and natural seasonings in snack foods. The acceptance of snacks is critical because of the specific quality attributes that attract people. Hence, this study was undertaken with an objective to know the availability of different extruded snacks in the local market and make a comparative evaluation of different attributes of these snacks.

Moreover, there is no concise information available regarding the various attributes of existing snacks, the study will act as a guideline for an entrepreneur in selection and combination of raw material for healthy extruded snacks.

MATERIALS AND METHODS

Twelve samples of RTE snacks available in the market were bought from local grocery stores. The information as reported by the manufacturer on the package was compared and tabulated to study the

Corresponding Author's Email: jagbir@pau.edu

compositional status and price of these extruded snacks (Table 1). The nutritional information as derived from the labels was also tabulated for comparative study. Extruded samples were further analyzed for the parameters not given by the manufacturer on the label as follows.

Chemical Composition

Samples were ground in a laboratory mill (Model No.3303, Perten Instruments AB, Huddings, Sweden) to pass through an 80-mesh sieve. The moisture content of the ground products was determined using (AACC, 2000). The ash content was determined from the percentage of combusted material following heating in a furnace at 550º C (AACC, 2000).

Physical Properties: A 50ml graduated measuring cylinder was tared and gently filled with extruded sample. The bottom of the cylinder was repeatedly tapped gently on a laboratory bench until there was no further reduction of sample volume. Bulk density was calculated as weight of the sample/volume (Hwang and Hayakawa,1980). All measurements were done in triplicate and results reported as kg/m3.

$\rho = Wp / Vc$

Wp =Weight of sample (kg)

Vc =Volume of cylinder (m3)

ρ=Density (kg/m3)

Color

Color of extruded samples was measured using a Hunter Laboratory Instrument Model CIE 1996 (Hunter Associates Laboratory, Inc., Reston, Virginia, U.S.A.) and expressed in terms of the 'L' (lightness (100) or darkness (0)), 'a' (redness (+) or greenness (–)), and 'b' (yellowness (+) or blueness (–)). A white calibration plate (L = 91.08, a = –1.25 and b = 1.43) was used as a standard for the measurements (Altanet al,2008). Ground and sieved samples (sieve #48 mesh) were taken. For each sample, three measurements were taken and averaged. ΔE signifies the total color difference which was calculated as Matthey and Hanna (1997).

$\Delta E = (\Delta L2+\Delta a2+\Delta b2)1/2$

Where ΔL = Lsample- Lstandard

Δa = asample- astandard

Δb = bsample- bstandard

Gas analysis

The gas analysis was done by a Gas Analyzer, Systech Instruments (Model GS3) and percentage of oxygen, carbon dioxide and nitrogen present in the pack were recorded.

Texture analysis: The texture of the snacks is an important parameter for consumer acceptability. The hardness of samples was measured using Stable Microsystems TA-HD Texture Analyzer (Texture Technologies Corp., Scarsdale, NY, USA) fitted with a 250 kg load cell. The probe (P 75) was moved at the test speed of 0.5mm/sec for a distance of 50 mm. Maximum force needed to break the samples was recorded and analyzed by Texture Exponent software associated with the texture analyzer and reported as Hardness (N) giving an average of three to four replicates (Kaur *et al*, 2014).

Functional Properties:

A 2.0 g ± 0.005 g sample was placed in a tared centrifuge tube and 20 ml distilled water added. After standing for 15 min (with intermittent shaking every 5 min), the sample was centrifuged at 4000 rpm for 15 min. The supernatant was decanted into a tared aluminum pan and weight gain in the gel was noted (Rehal *et al*, 2015). Water absorption index (WAI) was calculated as the increase in weight of sediment obtained after decanting the supernatant as:

WAI= Weight of wet sediment (g)/weight of dried sediment (g)

The supernatant was evaporated to dryness at 105°C until constant weight. Water solubility index (WSI) was determined as Nyombaire *et al* (2011).

WSI= [(weight of dried supernatant)/ (weight of dry sample) X 100].

RESULTS AND DISCUSSION

Chemical Composition

The major ingredients of extruded snacks as listed on the labels were rice meal, corn meal, gram meal, soy flour, potato flour, spices and condiments (onion powder, red chili powder, garlic powder, tomato powder, milk solids, cheese blends), flavor enhancers, citric acid, anti caking agents, coloring compounds and anti-oxidants. All the manufactures had listed only the ingredients without listing their proportion/percentage (Table 1).Price variation fell in the range of Rs 147/kg- Rs 555/kg with an exception of sample 11 for Rs 1416/kg and sample 12 for Rs 2000/kg since they were not indigenous. The average weight of the pack varied between 25-68g as shown in table 1.

All the snacks except for sample 1 listed the composition of protein, carbohydrate and fat as given in table 2. The fat content was highest for sample 10 with a value of 35.6 per cent and minimum for sample 9 with 3.15 per cent. The carbohydrates varied from 4.0 to 70.9per cent. Sample 9 extruded from rice reported minimum protein content of 2.8per cent. Wheat semolina and corn have higher protein content in comparison to rice (Dehghan-Shoar *et al*, 2010). The energy obtained from the snacks ranged from 137-607 kcal where sample 9 reported the minimum calorific value due to minimum amount of fat, protein and carbohydrates. Sample 12 had the highest amount of fat 42.9 per cent hence delivering maximum energy. The mineral content was reported by few manufactures only with sample 12 showing the highest sodium content of 1.71 per cent while sample 6 showed the highest calcium content of 668.5 mg (Table 2).

Moisture content is the most important factor in both processing of the snack as well as the storage. All the extruded snacks reported moisture content in the range of 3.71 to 9.24. Moisture content below 10per cent is considered safe to prevent any microbial growth. The sample 1 had the maximum moisture content of 9.24per cent. Since the mineral percentage was not listed for all the snacks hence it was determined by following the standard procedures (Table 3). It indicated the amount of minerals present varied between 1.36 to 4.12per cent. The snacks studied reported lack of micronutrients. Only 2 samples listed the presence of micronutrients on their nutritional label.

Physical Properties

Bulk Density

The bulk density of the extruded snacks varied from 107.69 to 763.64 kg/m3 and is tabulated in table 3. The bulk density of 763.64 kg/m3 implied minimum expansion. The expansion was inversely proportional to the bulk density and was greatest for low protein. A 3-dimensional protein network by gluten proteins and water decreases the starch swelling (Champenois *et al*,1998).This is contrary to the previous results that addition of protein to starchyextrudate reduced the expansion of product by reducing the extensibility of starch polymer during its expansion at the die exit (Derby *et al*, 1975). The high protein content in sample 3 to 8 did not increase the bulk density of the extruded snack as the protein was not incorporated in the premix but rather coated over the extruded product. The coated protein had no role in altering the gelatinization of starch or the structure of protein, hence did not affect bulk density.

Color

The L values varied in the range 52.19 to 79.76 as given in table 3.Sample 1 was the lightest having maximum value of L as its ingredients were potato powder, starch and refined oil secondly, higher L values were due to rise in the number of air cells. The minimum L value of 52.19 was recorded for Sample 2 due to presence of corn meal, grain meal and wheat bran making it darker in color. The value of 'a' (redness) and 'b' (yellowness) were maximum for sample 11 and 12 due to the presence of tomato powder and added color. Samples with higher 'a' values were darker and had lower 'L' values (Altan *et al*, 2008).

The packaging of ten out of twelve samples were in laminated pouches and the remaining two were

Table 1. Details of the extruded snacks as available on the labels

Sample No. and name		Ingredients	Manufacturer	Wt. (g)	Price (Rs)
1.	Sai Lite-N-Fit	Potato powder, starch, vegetable refined oil and starch	Sai Gram Udyog, Paschim Vihar,Delhi	35	80
2.	Bingo TedheMedhe	Rice meal, edible oil, corn meal,gram meal, spices and condiments(onion powder 2.8%,red chili powder 1.1%,Coriander powder 0.2%),Salt (2.1%), maltodextrin, Acidity regulators(296,330,334),Tomato powder, sugar, hydrolysed vegetable protein, anti-caking agent 551, flavor enhancers 627 &631.	ITC Ltd, Foods division, snacks unit, Bhel,Haridwar	68	10
3.	Bingo Mad Angles	Rice meal, edible oil, corn meal, gram meal,sugar, salt, spices and condiments(red chili powder 0.2%) milk solids, hydrolysed vegetable protein, malto dextrin, acidity regulators(296,330) emulsifier (414), anti-caking agent(551),wheat fiber, anti-oxidant (320)	ITC Ltd,Bhel,Haridwar	50	10
4.	Peppy Tomato Discs	Wheat flour, edible starch, edible vegetable oil, flour of soya and corn, sugar, tomato powder, onion powder, chili powder, malto dextrin, black pepper, acid (E 296, E 330), salt, baking powder, ground spices, Color(E 150) and condiments.	Venkataramana Food Specialities Ltd (VFSL), Bhind, M.P.	25	10
5.	Peppy Cheese Balls	Whole corn, vegetable oil, blend of whey, malto dextrin. Cheese powder, salt, sodium phosphate, flavor enhancer (E621) acid (E 270, E 330) Color (E 160 C) and yeast extract.	Venkataramana Food Specialities Ltd(VFSL),Bhind, M.P.	27	15
6.	Crax Corn Rings-masala	Corn meal, edible vegetable oil, spices and condiments, sugar, salt, acidifying agents and starch.	DFM Foods Ltd, Roshan Hara Road, Delhi.	45	10
7.	Crax Corn Rings-Chatpata	Corn meal, hydrogenated vegetable oil, spices, salt, permitted flavors and citric acid.	DFM Foods Ltd, Roshan Hara Road, Delhi.	45	10
8.	Pik-Nik Classic	Wheat flour, edible starch, edible vegetable oil, flour of soya, corn and potato, salt, sugar, tomato powder, onion powder, garlic powder, chili powder, malto dextrin, acid (E 296, E 330), baking powder, ground spices, Color(E 150) and condiments.	Venkataramana Food Specialities Ltd. (VFSL) Bhind, M.P	25	10
9.	Fun Flips Rice Puffs	Rice, Pulse, maize, edible vegetable oil, spices, edible salt and citric acid.	Fun choice, Shadara, Delhi	30	5
10.	Kurkure	Rice meal, edible vegetable oil, corn meal, gram meal, spices and condiments(onion powder, chili powder, amchur, coriander powder, ginger powder, garlic powder, black pepper powder, turmeric powder, fenugreek powder) salt , black salt , tomato powder, sugar , citric acid, tartaric acid.	Pepsico India holding Pvt Ltd (Frito lay division) Gurgaon, Haryana.	55	10

11.	Fisher Cheez Curlz	Degerminated yellow corn meal, soya bean and/or canola oil, dried cheese blend (whey, sunflower oil, semi soft cheese {pasteurized milk,cheese culture, salt, enzymes},lactose, food starch – modified, malto dextrin, whey protein concentrate, salt,sodium phosphate, natural flavor, citric acid, Yellow6, yellow 5,lactic acid)	America's best canister snacks, Boonton, NJ 07005	120	170
12.	Fisher Pizza Ballz	Degerminated yellow corn meal, sun flower seed and / or soya bean and / or canola oil , dried cheese blend (whey, sunflower oil, semi soft cheese{pasteurized milk ,cheese culture, salt, enzymes},lactose, food starch – modified, malto dextrin, whey protein concentrate, salt, sodium phosphate, natural flavor, citric acid, Yellow 6, yellow 5,lactic acid), Tomato powder, monosodium glutamate, sugar, whey protein concentrate, spices, lactose, onion and garlic powder, disodiuminosinate and guanylate, salt , citric acid	America's best canister snacks, Boonton, NJ 07005	85	170

Table 2. Nutritional information available on the labels of extruded snacks.

Sample No.	Product	Energy (kcal)	Total Fat	Total CHO	Protein	Na (g)	Vit C (mg)	Fe (mg)	Ca (mg)	Sugar (%)
1.	Sai Lite-N-Fit	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
2.	Bingo Tedhemedhe	558	35.6	51.9	7.5	N.A	N.A	N.A	N.A	2.6
3.	Bingo mad Angels	534	30.8	55.9	8.3	N.A	N.A	N.A	N.A	3.4
4.	Peppy Tomato Discs	505.2	26.3	59.2	8.0	N.A	N.A	N.A	N.A	6.2
5.	Peppy Cheese Balls	473	17	70.9	9.2	N.A	N.A	N.A	N.A	1.0
6.	Crax Corn Rings-masala	502.6	25.2	63.9	5.2	0.001	N.A	25.74	668.5	N.A
7.	Crax Corn Rings-Chatpata	463.9	18.7	67.6	6.4	0.013	N.A	30.50	291.6	N.A
8.	Pik-nik Classic	513	27.6	57.6	8.7	N.A	N.A	N.A	N.A	5.6
9.	Fun Flips Rice Puffs	137	3.15	22.18	2.8	0.23	N.A	N.A	N.A	N.A
10.	Kurkure	561	35.7	53.6	6.4		N.A	N.A	N.A	3
11.	Fisher Cheez Curlz	635	18.0	4.0	7.1	17.1	N.A	N.A	400	7.14
12.	Fisher Pizza Ballz	500	12.0	5.0	7.1	4.5	20	200	0	7.14

N.A means 'Information Not Printed'

Table 3. Estimated parameters of the extruded snacks

Sample No. and Name		Moisture Content (%)	Ash (%)	Bulk density (kg/m3)	L	a	b	ΔE O2	Gas analysis(%)			Max. Force (N)
									CO2	N2		
1.	Bingo tedhemedhe	4.72	2.09	763.64	55.10	14.52	25.12	45.95	2.54	0.3	97.2	16.66
2.	Bingo mad angels	4.24	2.04	753.20	52.19	11.47	23.32	46.40	11.7	0.8	87.5	35.37
3.	Peppy Tomato discs	5.51	2.98	148.88	52.63	10.27	20.22	44.31	19.3	0.6	80.1	5.09
4.	Peppy cheese balls	6.55	1.36	130.29	58.92	22.40	29.64	48.88	20.9	0.2	78.9	14.50
5.	Crax masala	5.39	2.85	188.39	61.24	7.71	30.64	42.70	20.9	0.3	78.8	25.57
6.	Craxchatpata	3.71	4.12	157.54	61.27	4.93	28.58	40.79	20.9	0.4	78.7	22.73
7.	Piknik tomato chilli	5.85	2.86	139.25	52.20	14.02	22.47	46.77	20.9	0.4	78.7	12.15
8.	Funflips	4.56	2.47	107.69	57.55	19.57	25.55	46.26	15.8	0.3	83.9	15.09
9.	Kurkure	3.41	2.55	522.46	53.87	15.58	24.95	47.12	20.9	0.2	78.9	14.50
10.	Fisher cheese curlz	8.13	2.68	436.47	55.79	32.58	30.10	56.67	19	0.4	80.6	12.44
11.	Fisher pizza ballz	8.11	2.53	170.81	54.91	30.47	29.19	55.43	20.9	0.4	78.7	11.66
12.	Lite n fit potato extrudates	9.24	2.82	269.82	79.76	0.39	13.68	16.75	21.8	0.0	78.2	48.71

packed in laminated card boards. The gas analysis of the laminated pouches revealed the presence of nitrogen gas in the range of 78.2-97.2 per cent. Nitrogen being an inert gas helps to prevent the oxidation of oil which leads to rancidity.

Texture analysis

The hardness is the maximum force required for a probe to penetrate the extrudates. The feed moisture was the main factor affecting the density and expansion. The high density and low expansion produces a harder extrudate (Liu *et al*, 2000). Maximum force of 48.71 N was recorded for sample 1(Table 3). It could be due to high carbohydrate content i.e. potato starch, and secondly due to its moisture content (9.24 %). Increase in moisture increases the bulk density of the extruded products making it more dense and hard. The sample 3 had more force of 35.38 N as its carbohydrate (55.9%) and protein (8.3%) was comparatively higher when compared to other samples. Wheat has a higher protein and lower starch content compared to rice and corn, therefore extruded wheat products are harder and less expanded (Riaz, 2006). They are often described as crunchy because of a complex failure mechanism that involves the repetitive deformation and fracturing of the cell structure. These products exhibit a classical brittle failure mechanism as a consequence of their cellularity and lack of structural resiliency.

Functional Properties

Water absorption and solubility index:

Water absorption index is an important functional characteristic in extruded products as high water absorption index assures cohesiveness of the product. It gives an indication of the amount of water needed to form gruel. Water solubility index describes the rate and extent to which the component of powdered extruded material is dissolved in water which depends on its chemical composition and physical state. It is used as an indicator of degradation of molecular components, measures the degree of starch conversion during extrusion which is the amount of soluble polysaccharides released from the starch components after extrusion. The water absorption index of the snacks varied from 3.77 to 5.31 whereas the water solubility ranged from 19.8 to 34.The difference observed could be attributed to the nature of the raw materials and the extrusion conditions like moisture content, screw speed, extrusion temperature etc.

CONCLUSION

The market demand of RTE snacks is likely to increase exponentially in the coming years due to the convenience attached with them. Economically, from the entrepreneur point of view RTE have a huge potential as a profitable venture. The RTE snacks available in the market right now are costly as well as nutritionally inadequate. A competitive product with better nutritional quality should be made available to the consumers which can be achieved by exploring cheaper but nutritional alternatives with an aim of lowering the cost and enhancing the nutritional composition of the product. For a manufacturing entrant, the study will be very useful as it provides the values for different parameters such as moisture, hardness, water solubility index, water absorption index and color.These parameters play an important role in selection of ingredient during the designing of a new product, but are not listed on the label of these products. There is a void in the snack market for meeting specific needs of target customers with specific health issues which can be explored by the entrepreneurs.

REFERENCES

AACC (2000). *Approved methods of American Association of Cereal Chemists* (10th ed.).St. Paul. MN: The Association.

Altan A, McCarthy L, Kathryn M M (2008). Extrusion cooking of barley flour and process parameter optimization by using response surface methodology. J *Sci. Food Agri* **88**(9):1648–1659.

ChampenoisYM, RaoA and Walker LP (1998).Influence of α-amylase on the viscoelastic properties of starch-gluten pastes and gels. *J Sci Food Agri* **78**: 127-133.

Dehghan-Shoar Z, HardacreAK and BrennanC S (2010). The physico-chemical characteristics of extruded snacks enriched with tomatolycopene. *Food Chem* 123 (4): 1117-1122.

Derby R I, Miller B S, Miller B F and Trimbo H B (1975). Visual observation of wheat-starch gelatinization in limited water systems. *Cereal Chem* **52**: 702-713.

Hwang M P and Hayakawa K I (1980). Bulk densities of cookies undergoing commercial baking processes. *J Food Sci* **45**: 1400–1402.

Jamora J J, Rhee K S and Rhee K C (2002). Chemical and sensory properties of expanded extrudates from pork meat-defatted soy flour blends with onion, carrot and oat. *J Food Sci and Nutr* **6**:158–162.

Kaur G J, Rehal J, Singh A K, Singh B and Kaur A (2014). Optimization of extrusion parameters for development of ready-to-eat breakfast cereal using RSM. *Asian J Dairy and Food Res* **33** (2): 77-86.

Rehal J, Kaur G J, Kaur A and Singh A K (2015). Evaluation of Physicochemical and Functional Properties of Cereal Based Porridges Available in Indian Market. *Intl J Sci Adv Res Technol* **1**(6):90-98.

Liu Y, Hsieh F, Heymann H and Huff H E (2000). Effect of process conditions on the physical and sensory properties of extruded oat-corn puff. *J Food Sci* **65**:1253-1259.

Matthey F P and Hanna M A (1997). Physical and functional properties of twin-screw extruded whey protein concentrate–corn starch blends. LWT - *Food Sci and Technol* **30**: 359–366.

Mazumder P, Roopa B S and Bhattacharya S (2007).Textural attributes of a model snack food at different moisture contents. *J Food Engg* **79**(2): 511-516.

Nyombaire G, Siddiq M and Dolan K D (2011). Physico-chemical and sensory quality of extruded light red kidney bean (Phaseolus vulgaris L.) porridge. LWT - *Food Sci Technol* **44**:1597-1602.

Riaz M N (2006). "*Extruded snacks*". In: Handbook of Food Science Technology and Engineering. (edsY H Hui)Vol. 4. Baco Raton, FL: CRC Press.

Received on 26/09/2016 Accepted on 15/12/2016