

## Egg consumption: patterns, preferences and perceptions among consumers in Accra metropolitan area

<sup>1</sup>Ayim-Akonor, M. and <sup>2</sup>Akonor, P. T.

<sup>1</sup>Animal Health and Food Safety Division, CSIR-Animal Research Institute, P. O. Box AH20 Achimota-Accra, Ghana

<sup>2</sup>Food Processing and Engineering Division, CSIR-Food Research Institute, P. O. Box M20 Accra, Ghana

### Article history

Received: 22 March 2014

Received in revised form:

18 May 2014

Accepted: 1 June 2014

### Keywords

Egg consumption

Consumer perception

Purchasing behavior

Consumption pattern

### Abstract

Despite the numerous nutritional and health benefits the eggs presents, its consumption is limited because it is, rather erroneously, associated with incidents of cardiovascular diseases. In this study, consumption patterns, preferences and perceptions among consumers in the Accra Metropolis was determined in a cross-sectional study. A structured self-administered questionnaire was used to collect information pertaining to patterns, preferences and perceptions from 448 participants. Close to 95% of the participants were found to be egg consumers. Their demographic indices did not significantly ( $p > 0.05$ ) influence consumption, except for age, with older respondents consuming less frequently. Size and price were the most influential indices that drive consumer purchase. Majority (47.6%) liked eggs from locally-bred chicken raised on free range basis better than that obtained from birds raised under confined conditions. Also, large sized, brown eggshell, and deep yellow yolk were most preferred. Boiled eggs were found to be the main food form patronized by consumers in the study area. More than half of the participants held the view that egg consumption results in an increase in serum cholesterol, even though this thought has not been sufficiently demonstrated scientifically. This study illustrates the need to publicize accurate information about the nutritional and health benefits of table eggs based on sound scientific evidence.

© All Rights Reserved

### Introduction

Egg is generally considered as a complete food and is an excellent source of easily digestible proteins, vitamins, minerals, carotenoids and fatty acids (Song and Kerver, 2000) that are required for proper nutrition. It is common in most parts of the world and plays a very important role as far as the consumption of proteins from animal sources is concerned. Globally, egg production has grown rapidly in recent years and even promises to rise further (FAO 2010), with the introduction of advanced and better poultry management systems. In Ghana, production of eggs has seen a steady increase, although not at the same rate as poultry meat. An increase of nearly 15,000 tons was recorded between year 2004 and 2012 (FAOSTAT, 2013). In as much as other poultry such as turkey, guinea fowl, ducks, pigeons and ostriches are kept (Aning, 2006), a bulk of table eggs is obtained from chicken.

Egg consumption differs widely among countries, with per capita consumption being high among the developed countries. Per capita consumption for Ghana is low and reported as 12 eggs per year (Aning, 2006), a rate which is more than 10 times smaller than the world average. Eggs are vastly versatile in

their usage. It is utilized as an ingredient in several culinary and industrial applications including baking and processing of ice cream and other desserts. Among Ghanaians customarily, it is boiled, fried or stewed and used in domestic meal preparation with commercially raised chicken being the major source of supply. Eggs are also thought to possess spiritual potency and therefore are used to perform certain rituals during festive occasions or in times of need.

Eggs have been a source of scandal and panic (Fearne and Lavelle, 1996a), with its nutritional/health information inaccurately disclosed and as such its real biological value is not cherished. Specifically, egg consumption has been associated with an increase in serum cholesterol and incidents of cardio-vascular diseases (CVDs) (Kritchevsky and Kritchevsky, 2000). These speculations still remain rife, to the extent that, although production increases annually (FAOSTAT, 2013), consumption is rather low. The need therefore arises to ascertain some of the key factors and reasons that drive or restrict the consumption of eggs. This study seeks, as its objective, to determine the preferences, perceptions and consumption pattern of table eggs, among consumers. Findings from this study would form the basis for developing strategies to address the rather

\*Corresponding author.

Email: [m.ayimakonor@gmail.com](mailto:m.ayimakonor@gmail.com)

Tel: +233 262013220

low egg consumption in Ghana in order create an avenue for consumers to tap into the nutritional and benefits of table eggs

## Methodology

### *Study area*

A cross-sectional study of egg consumption pattern was conducted in the Accra Metropolis in the last quarter of year 2013. This study area, described elsewhere (Akonor and Akonor, 2013), was chosen because of its cosmopolitan and urbanized nature. Also, no previous study on this subject has been conducted in this area.

### *Study population and data collection*

A total of 448 respondents with varying demographic characteristics participated in the research. Data was collected using a self-administered structured questionnaire consisting of two main sections: demographic characteristics and egg consumption pattern, perceptions and preferences. The questionnaire mainly contained closed ended questions. This was pretested with 20 respondents in the study area, improved and eventually used for the survey. In order to capture people with varying educational background, questions was read out to respondents who could not read and write and their responses recorded appropriately on the questionnaire. Respondents, whose schedule did not allow them to complete the questionnaire on the spot, had the liberty of returning their completed questionnaire at a later date.

The study area was segmented into 6 areas and at least 70 respondents from each area were randomly selected to participate in the survey. The inclusion criterion was for a participant to be willing to participate in the study. After briefly explaining the purpose, respondents who agreed to participate in the study were made to sign a consent form. In order to guarantee anonymity of responses, questionnaires were identified by a 3-digit code, instead of respondents' name.

### *Data processing and analysis*

Responses from the survey was coded and entered into the Statistical Package for Social Sciences (SPSS v 17.0.1, SPSS Inc, 2008) and analyzed using descriptive statistics. The association between demographic data and egg consumption pattern was tested using chi square, with a p-value of less than 0.05 considered statistically significant. Pre-test questionnaires were not included in the analysis.

## Results and Discussion

### *Socio-demographic characteristics of respondents*

Table 1, which presents the demographic characteristics, shows a highly educated study population, more than half of which was male. Their ages ranged from 18 to 66 years with the modal age being < 30 years. Respondents were composed of both high and low income earners. Nearly 50% were found to earn more than GH¢1000 per month, while a small section (10.5%) had an income of less than GH¢100.

### *Respondents' egg consumption pattern*

Different eggs consumption trends were observed among participants in this survey. A total of 26 out of 448 participants did not consume eggs for one reason or the other (Figure 1). This group of respondents was observed to increase with age (Figure 1), with those older than 60 years making nearly 80% and those less than 30 years making up less than 5%. For these respondents, their reasons for not eating eggs were based on nutritional/health concerns. However, to one respondent who was vegetarian, the option to abstain from eggs was purely religion.

Consumption of eggs among the participants was widespread and differed considerably among the age categories in the study. Overall, 94.2% were found to eat eggs at least once in a month. As presented (Figure 2) respondents who consume eggs frequently ("more than once a day" or "once a day") made up the minor categories as opposed to those who consume on weekly or monthly basis. Consumption and usage of eggs is largely limited by changing lifestyle and an increasing concern about dietary cholesterol and its association with coronary heart diseases (Kennedy, 2000).

Egg consumption and its frequency was observed to be influenced by age alone ( $\chi^2 = 61.389$ ,  $p < 0.0001$ ). Generally consumption was higher among the younger age categories, with nearly 29% of people younger than 30 years consuming at least once a day. This observation might be due to the fact older people tend to be more health conscious and mindful of what they eat. They are skeptical and generally have a negative perception about eggs because it is thought to be associated with CVDs. This perception places the elderly among the "high risk" category of consumers and as such, for the purpose of health preservation, most of them hardly eat eggs. A recent study, however, has suggested the consumption of one egg per day provides certain carotenoids that are effective in preventing age-related macular

Table 1. Demography and egg consumption among respondents

Variable	Frequency	Percentage (%)	$\chi^2$	p-value
<i>Gender (n=422)</i>				
Male	219	51.9	2.483	0.116
Female	203	48.1		
<i>Age(years)(n=422)</i>				
Less than 30	210	49.8	61.389	<0.0001
30-60	183	43.3		
>60	29	6.9		
<i>Educational level (n=422)</i>				
Below secondary	49	11.6	1.279	0.734
Secondary	145	34.4		
Tertiary	228	54.0		
<i>Income (per month)(n=422)</i>				
<100	44	10.4	16.334	0.072
100-1000	176	41.7		
>1000	202	47.9		
<i>Egg consumption (n=448)</i>				
Yes	422	94.2	106.879	<0.0001
No	26	5.8		

Table 2. Period of day when eggs are consumed (n=422)

Variable	Percentage (%)	p-value
Morning	25.8	0.016
Afternoon	18.5	
Evening	13.5	
Anytime of day	42.2	

Table 3. Popular food forms of eggs (n=422)

Variable	Percentage (%)	p-value
Boiled	53.3	0.032
Fried	30.8	
Stewed	10.4	
Both fried and stewed	5.5	

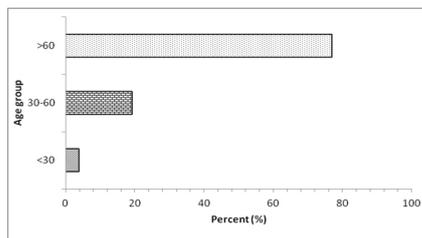


Figure 1. Respondents who do not eat eggs

degeneration (Bertechini and Mazzuco, 2013). As regards the other demographic indices such as sex, educational and income levels, consumption was fairly evenly distributed and showed no marked differences ( $p > 0.05$ ) among these groups. Notwithstanding the afore-mentioned, certain variations were found for respondents of different groupings (Table 1). Apart from chicken, other sources of eggs as reported by the participants are ducks, guinea fowl and turkey (Aning, 2006), even though these eggs are not very popular. Ducks, turkey and guinea fowl are mainly raised in small numbers on subsistence basis for their eggs and meat as a protein source or emergency cash for the family.

### Time of day for egg consumption among respondents

Table 2 presents the times at which consumers usually eat eggs. As shown, consumption of eggs is

Table 4. Influential egg purchasing factors

Parameter	Rank	Mean Score
Size	1 <sup>st</sup>	3.5±1.1 <sup>a</sup>
Price	2 <sup>nd</sup>	2.8±0.4 <sup>ab</sup>
Cleanliness	3 <sup>rd</sup>	2.3±0.4 <sup>b</sup>
Colour	4 <sup>th</sup>	1.2±0.1 <sup>c</sup>

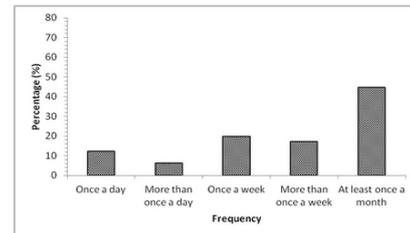


Figure 2. Frequency of egg consumption

spread across the day but was found to be lower in the evening, probably for fear of accumulation of energy since physical activity is reduced around this time of day. Although a majority of respondents were found as having a definite time for consumption, a considerable proportion (42.2%) had no restrictions of time and would consume eggs as and when it is available. Almost 26% of participants would choose to eat an egg in the morning (breakfast) compared to 18.5% and 13.5% who would consume it in the afternoon and evening respectively. This trend is unlike those observed in the USA and Canada where eggs are predominantly eaten at breakfast (Guyonnet, 2013).

### Common forms into which eggs are processed

The most common forms into which eggs are processed in Ghana are presented in Table 3. Regardless of fried eggs' superior organoleptic features, hard-boiled egg constituted the majority of egg forms consumed by the respondents (Table 3). More than half of the participants preferred this form while the rest would rather it be fried or stewed. Preference for boiled eggs may result from its ease of cooking, low cost and convenience. Furthermore, egg in this form is vended severally along major roads and street corners as well as bus terminals which makes it more accessible. Consumer health concerns that have arisen in recent times about limiting the intake of fat may also partly account for this observed trend.

### Factors determining egg purchasing

Size, price, appearance, and other quality attributes have been established to influence consumer purchasing behavior and egg preference in different regions worldwide (Fearne and Lavelle, 1996a; Bejaei *et al.*, 2011; Jibir *et al.*, 2013). An assessment of these indices showed (Table 4) that size is the most important parameter considered by respondents when purchasing eggs, followed by price and cleanliness.

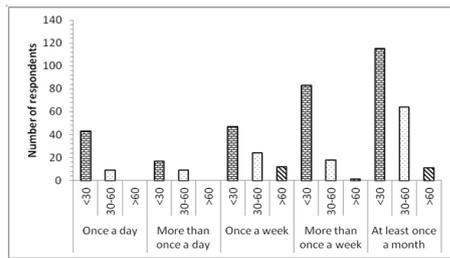


Figure 3. Distribution of egg consumption by age group

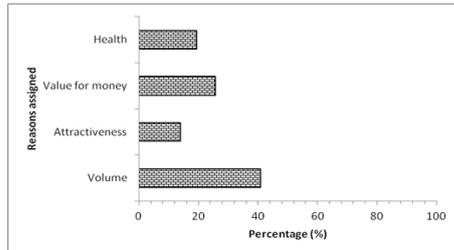


Figure 4. Egg size preference

Size and price have always been important determinants of purchase, with an overwhelming likeness for large eggs. These two indices go hand in hand and are considered key in terms of obtaining the maximum benefit of purchased products. This observation appears to be in agreement with Fearne and Lavelle (1996b).

Cleanliness was rated almost as high as price probably because of public health concerns that have arisen in the recent past regarding salmonellosis from egg consumption, and the outbreak of certain poultry diseases. Dirt and or fecal matter that stain eggs may contain pathogenic organisms which can contaminate eggs make them unwholesome and therefore a public health risk (DeWinter *et al.*, 2011). The influence of eggshell color, as in the case of Fearne and Lavelle (1996a), was downplayed by participants since they ranked it last among the parameters that influence the decision to purchase eggs.

**Consumers egg preference**

Egg preference was assessed using its source (local/free range or commercial/confined) and some physical characteristics of both eggshell and yolk. With regards to the source, respondents’ preference was skewed in favor of eggs from local chicken (47.6%) which are run on free range. These chickens eat from a wide range of sources and are therefore thought to produce more nutritious eggs, compared to regular chicken which are kept confined, for commercial purposes. Preference for free range eggs have been reported in previous studies by Fearne and Leville (1996a) and Bejaei *et al.* (2011). The preference of respondents notwithstanding, free-range eggs are seldom sold on local markets, leaving consumers with no choice but to settle for eggs from birds kept under deep litter system. These eggs on

Table 5. Eggshell and egg yolk colour preference

Parameter	Color	Percentage (%)	X <sup>2</sup>	p-value
Egg shell	White	12.8	40.820	<0.0001
	Brown	32.0		
	Any	55.2		
Egg yolk (n=415)	Off white	7.7	93.909	<0.0001
	Pale Yellow	16.2		
	Deep yellow	76.1		

Table 6. Does egg consumption cause disease (n=422)

Variable	Percentage (%)	p-value
Yes	51.9	<0.0001
No	35.8	
Not sure	12.3	

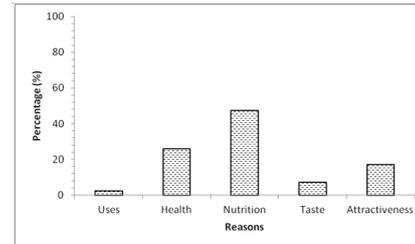


Figure 5. Reasons associated with choice of egg yolk color

the other hand are perceived to be safer since they are produced under standardized and controlled conditions. Participants who fancied eggs from this source accounted for 43.8% of the study population. The last group of participants (8.6%) was not sure of their choice of egg source and was therefore indifferent in their response to the question about preferred source of table eggs.

**Respondents egg size preference**

The preference for large-sized eggs was quite remarkable. Most (56.3%) of the respondents would select large eggs as their preferred choice when shopping for eggs, 38.2% preferred medium and the remaining 5.5% selected small-sized eggs as their choice. Respondents’ option for the different egg sizes were attributed to diverse reasons. Specifically, as illustrated in Figure 4, their responses were motivated mainly by amount (40.8%) and value for money (25.8%). Some (19.4%) also attributed their preference for big eggs to the claim that big eggs are healthier and are laid by well-fed chickens, while the remaining 14.0% of respondents ascribed their choice to attractiveness. This result lends more credence to the fact that size is the most important attribute considered when consumers shop for eggs. Some previous studies in different parts of the world (Jacob *et al.*, 2000; Hashimoto *et al.*, 2011; Jibir *et al.*, 2013) have also shown consumer preference for large-sized eggs. Medium and small-sized eggs were chosen by 38.2% and 5.5% of respondents correspondingly. The main reason for their options was that, smaller eggs do not break easily and comes from hens that have not been given much medical/chemical intervention

and as such are presumed to be natural.

### **Respondents eggshell and egg yolk colour preference**

Colour influences the consumer's perception of products greatly and has been described as one of food's most important appearance characteristics (Maskan, 2001). Contrary to this assertion, colour of egg shell did not constitute a significant basis for respondents' preference in this study. Most (55.2%) of the participants were indifferent to egg colour. This outcome is discordant with reports that eggshell color is an important quality which affects consumer choices (Cavero *et al.*, 2012; Soria *et al.*, 2013). Indeed, there is no association between eggshell color and nutrient content and for that matter health benefits (Scott and Siversides, 2000). Between the two eggshell colors, however, brown was preferred to white. This may be due to perception that brown eggs are healthier and more natural compared to white eggs (Scott and Siversides, 2000). The observation corroborates previous findings to the effect that more brown eggs are consumed by Africans (Cavero *et al.*, 2012) and affirms the influence of regional preferences for particular egg types (Arthur and O'Sullivan, 2005; Johnston *et al.*, 2011).

Respondents' attitude towards yolk colour was unlike eggshell color (Table 5). As shown, fondness for deep yellow egg yolk was overwhelming ( $p < 0.0001$ ), compared to pale yellow and off-white colored ones. Although yolk color preference varies from one region to another, consumers usually prefer golden yellow to orange yolk and tend to relate this with good health (Hasin *et al.*, 2006). In this study as well, reasons assigned to respondents' choice of yolk color (Figure 5) were skewed in favor of proper nutrition and good health (more than 70%). Other reasons given as determinants of yolk color preference were related to taste, visual appearance and application as illustrated in Figure 5. Similar reasons were assigned by respondents in Bejaei *et al.* (2011) but Fearn and Lavelle (1996b) indicated that respondents were unable to distinguish between the tastes of eggs with different yolk color in a blind taste test. Proper pigmentation of egg yolk is important in the manufacture of several egg products as it influences the aesthetic properties of finished products.

### **Perceptions about egg consumption**

#### **Diseases**

Health is considered by consumers as a key

factor when confronted with the decision to eat eggs, since eggs are viewed in terms of cholesterol and its effect on the heart (Bertechini and Mazzuco, 2013). As shown in Table 6, a considerable percentage ( $p < 0.0001$ ) of the participants shared in the widely-held perception that consumption of eggs poses a health threat because it is believed to increase serum cholesterol. About 36% held a contrary view to this stance, while the remaining 12.3% were uncertain.

Generally, respondents associated heart-related diseases with egg consumption. The effect of egg consumption on serum cholesterol and incidence of certain diseases is pretty vague. Studies conducted in the recent past (Djousse and Gaziano, 2008; Li *et al.*, 2013) have shown egg consumption to be positively related with CVDs in diabetic subjects but the case of healthy individuals remains rather unclear. While some studies involving 'healthy' subjects revealed regular consumption of eggs as not being associated with coronary heart diseases (Hu *et al.*, 1999; Nakamura *et al.*, 2006; Zazpe *et al.*, 2011) others have proved otherwise (Kritchevsky, 2000). Bertechini and Mazzuco, 2013 maintain that studies linking egg consumption with CVD are flawed in its methodology, since it did not isolate the specific effects of cholesterol intake. These reports create ambiguities in the minds of consumers leaving them to make decisions based on hearsay and on information that lack empirical scientific basis. This situation has the potential of making consumers turn to alternative sources of animal protein which may be more expensive than eggs.

According to about 60% respondents, avian diseases do not influence their decision to consume eggs because these diseases cannot be contracted by this means. The remaining 40% speculated that an avian disease such as flu could infect a consumer and as such this would hold back their decision to eat eggs. This is not surprising since the incidence of bird flu and other poultry diseases have led to a reduction in egg consumption in certain areas. Transmission of bird flu through egg consumption has not been reported but eggs have been implicated in outbreaks of human salmonellosis mostly caused by *Salmonella enteritidis* (WHO/FAO, 2002; Murchie *et al.*, 2007). Most of the reported cases have been attributed to consumption of raw or undercooked eggs (Braden, 2006) and therefore, adequate processing of eggs is required in order to safeguard consumers against zoonotic poultry diseases that may be transmitted through egg consumption. The rather low consumption of eggs in Ghana may be attributed to these widespread perceptions.

## Conclusion

The findings of this study have demonstrated that gaps exist between scientific knowledge and consumer perception since the impression that eggs are a cause of CVDs prevailed among more than half of the respondents. This pervasive thought, which lacks ample scientific evidence, affects consumption among different age groups with younger participants more likely to consume more eggs than older ones. Consumer egg preferences varied widely regarding the source of eggs and other physical characteristics. Respondents' preferred eggs from free range birds, but price and size were the main driving forces behind consumers' decision to purchase eggs. In order to promote egg consumption, accurate and scientifically sound information about eggs should be made widespread in order to disabuse the minds of consumers about its association with CVDs.

## Acknowledgement

The authors deeply appreciate the tremendous help of Charity Boadua, for her assistance in the collection of data for this study.

## References

- Akonor P.T. and Ayim-Akonor, M. 2013. Food Safety Knowledge: The case of domestic food handlers in Accra. *European Journal of Nutrition and Food Safety* 3:99-111
- Aning, G.K. 2006. The structure and importance of the commercial and village based poultry in Ghana. Poultry Review-Ghana Final report. Food and Agriculture Organization of the United Nations.
- Arthur, J.A. and O'Sullivan, N. 2005. Breeding chickens to meet egg quality needs. *International Hatchery Practice* 19: 7-9.
- Aune, D., De Stefani, E., Ronco, A.L., Boffetta, P., Deneo-Pellegrini, H., Acosta, G. and Mendilaharsu, M. 2009. Egg consumption and the risk of cancer. A multisite case-control study in Uruguay. *Asian Pacific Journal of Cancer Preview* 10: 869-876.
- Bejaei, M., Wiseman, K. and Cheng, K.M. 2011. Influences of demographic characteristics, attitudes, and preferences of consumers on table egg consumption in British Columbia, Canada. *Poultry Science* 90: 1088-1095.
- Bertechini, A.G. and Mazzuco, H. 2013. The table egg: A review. *Ciencia Agrotecnologia* 37: 115-122.
- Braden, C.R. 2006. *Salmonella enterica* Serotype Enteritidis and Eggs: A national epidemic in the United States. *Clinical Infectious Diseases* 43: 512-517.
- Cavero, D., Schmutz, M., Icken, W. and Preisinger, R. 2012. Attractive eggshell color as a breeding goal. *Lohmann Information* 47: 15-21.
- DeWinter, L.M., Ross, W.H., Couture, H. and Farber, J.F. 2011. Risk assessment of shell eggs internally contaminated with *Salmonella enteritidis*. *International Food Risk Analysis Journal* 1: 40-81.
- Djousse, L. and Gaziano, M.J. 2008. Egg consumption in relation to cardiovascular disease and mortality: the Physicians' Health Study. *American Journal of Clinical Nutrition* 87: 964-969.
- FAO 2010. Agribusiness Handbook, Poultry meat and eggs. Downloaded from [http://www.eastagri.org/publications/pub\\_docs/6\\_Poultry\\_web.pdf](http://www.eastagri.org/publications/pub_docs/6_Poultry_web.pdf) on 6/2/2013.
- FAOSTAT 2013. Downloaded from <http://faostat.fao.org/site/569/DesktopDefault.aspx?PageID=569#ancor>.
- Fearne, A. and Lavelle, D. 1996a. Segmenting the UK egg market: results of a survey of consumer attitudes and perceptions. *Poultry Science* 98: 7-12.
- Fearne, A. and Lavelle, D. 1996b. Perception of food "quality" and the power of marketing communication: results of consumer research on a branded-egg concept. *Journal of Product and Brand Management* 5: 29-42.
- Guyonnet, V. 2013. Consumer perception towards eggs. *ISA Focus, The ISA Newsletter, Issue 9*. Downloaded from <http://www.isapoultry.com/company/newsletters/9.aspx> on 20/2/2014.
- Hashimoto, E., Nagano, M., Kobayashi, S. and Koizumi, S. 2011. Consumer behavior for egg in Japan. Downloaded from <http://hp.brs.nihon-u.ac.jp/~keiei/resource/ronbun/r96-5.pdf> on 5/2/2014.
- Hasin, B.M., Ferdaus, A.J.M., Islam, M.A., Uddin, M.J. and Islam, M.S. 2006. Marigold and Orange skin as egg yolk color promoting agents. *International Journal of Poultry Science* 5: 979-987.
- Hu, F.B., Stampfer, M.J., Rimm, E.B., Manson, J.E., Ascherio, A., Colditz, G.A., Rosner, B.A., Spiegelman, D., Speizer, F.E., Sacks, F.M., Hennekens, C.H. and Willett, W.C. 1999. A prospective study of egg consumption and risk of cardiovascular disease in men and women. *Journal of American Medical Association* 281: 1387-1394.
- Jacob, J.P., Miles, R.D. and Mather, F.B. 2011. Egg quality. University of Florida IFAS Publication No. PS24. Downloaded from <https://edis.ifas.ufl.edu/ps020> on 30/1/2014.
- Jibir, M., Isa, A.M., Adamu, I., Garba, S. and Jibrila, I. 2013. Value perception of shell egg characteristics as determined by size and colour. *Journal of Animal Science Advances* 3: 457-461.
- Johnston, N.P., Jefferies, L.K., Rodriguez, B. and Johnston, D.E. 2011. Acceptance of brown-shelled eggs in a white-shelled egg market. *Poultry Science* 90: 1074-1079.
- Kennedy, A. 2000. Producer's perspective on egg consumption: How does the market react? In Sim, J. S., Nakai, S. and Guenter, W. (Eds). *Egg Nutrition and Biotechnology*, p. 113-118. CABI Publishing, Wallingford, UK
- Kirtchevsky, S. and Kirtchevsky, D. 2000. Egg consumption and coronary heart disease: an epidemiological overview. *Journal of the American College of Nutrition*

19: 549-555.

- Li, Y., Zhou, C., Zhou, X., and Li, L. 2013. Egg consumption and risk of cardiovascular diseases and diabetes: A meta-analysis. *Atherosclerosis* 229: 524-530.
- Maskan, M. 2001. Kinetics of colour change of kiwifruits during hot air and microwave drying. *Journal of Food Engineering* 48: 169-175.
- Murchie, L., Whyte, P., Xia, B., Horrigan, S., Kelly, L. and Madden, R.H. 2007. Prevalence of *Salmonella* in Grade A whole eggs in the Island of Ireland. *Journal of Food Protection* 5: 1238-1240.
- Nakamura, Y., Iso, H., Kita, Y., Ueshima, H., Okada, K., Konishi, M., Inoue, M. and Tsugane, S. 2006. Egg consumption, serum total cholesterol concentrations and coronary heart disease incidence: Japan public health centre-based prospective study. *British Journal of Nutrition* 96: 921-928.
- Scott, T.A. and Silversides, F.G. 2000. The effect of storage and strain of hen on egg quality. *Poultry Science* 79: 1725-1729.
- Song, W.O. and Kerver, J.M. 2000. Nutritional contribution of eggs to American diets. *Journal of American College Nutrition* 19: 556S-562S.
- Soria, M.A., Bueno, D.J. and Bernigaud, I.I.C. 2013. Comparison of quality parameters in hen's egg according to egg shell color. *International Journal of Poultry Science* 12: 224-234.
- WHO/FAO 2002. Risk assessments of *Salmonella* in eggs and broiler chickens. Microbiological Risk Assessment Series 2. Downloaded from <http://www.who.int/foodsafety/publications/micro/en/salmonella.pdf> on 12/2/2014.
- Zazpe, I., Beunza, J.J., Bes-Rastrollo, M., Warnberg, J., de la Fuente-Arrilaga, C., Bonito, S., Vazquez, Z. and Martinez-Gonzalez, M.A. 2011. Egg consumption and risk of cardiovascular disease in the SUN project. *European Journal of Clinical Nutrition* 65: 676-682.