National Centre of Excellence in Functional Foods

FOOD, HEALTH AND NUTRITION: WHERE DOES CHICKEN FIT?

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FOREWORD

The Australian population suffers from a range of diet related diseases, particularly obesity and type 2 diabetes, which GPs and health care professionals need to help address.

High protein diets may play a significant role in helping overweight and obese subjects lose weight and maintain weight loss. Chicken is a key component of today's diet, with about 33 per cent of Australians who eat chicken doing so at least three times a week, and can contribute significantly to a high protein diet. Lean chicken can also contribute to a healthy eating pattern even if weight loss is not required.

Chicken can be very low in fat and provides essential vitamins and minerals, particularly niacin, vitamin A and vitamin E and magnesium, which should encourage GPs to recommend it to patients in their practices when reviewing and discussing an overall balanced diet.

This report aims to broaden the understanding of where chicken fits, nutritionally, in the Australian diet and what that means to the health of Australians. Chicken is generally recognised as a low fat protein source. The fact that it also provides a range of other valuable nutrients is less well known and this report fills this information gap.

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Competing Interests
None identified.

ABSTRACT

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The link between diet and health is important, given the prevalence of diet related disease, including obesity, in the Australian population. Consumers need to be able to discriminate between foods based on the nutritional contribution of each to a healthy diet. They also need to be able to discriminate between foods in a broader context, considering issues such as food safety, how the food is produced and the environmental consequences of its production. This review outlines the position of chicken in the Australian diet from a health, consumer and environmental perspective.

Chicken can contribute to a healthy eating pattern. It is an important source of protein. The predominant cut consumed, breast meat, is low in fat, with its fat profile favouring polyunsaturated, rather than saturated, fatty acids. Chicken meat delivers essential vitamins and minerals and is the most affordable meat source. As with all meats, care is required with preparation but consumers find it easy to use. The Australian chicken industry is a significant contributor to the economy and, of the land based animal production systems, chicken meat production creates the least environmental burden.

Keywords: Chicken meat, health, consumers, food safety, environmental sustainability

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This work was supported by a project grant funded by the Australian Chicken Meat Federation. The Australian Chicken Meat Federation (ACMF) is the peak coordinating body for participants in the chicken meat industry. It was formed in 1964 and is recognised by the Australian Government. It works to develop and promote the industry's capabilities and represents the industry's interests at the national level in matters regarding international trade, quarantine, animal health, biosecurity, food standards and food safety, and animal welfare.

INTRODUCTION

As science exposes the fine detail of the food-health relationship, practitioners need information to help guide patients in making healthy food choices. With the exception of breast milk in infancy, no single food provides all the nutritional requirements to sustain and protect the human body. The answer lies in the total diet, but achieving a balanced diet requires an ability to discriminate between foods. From a nutritional perspective this means appreciating the health and disease impacts of dietary patterns, individual foods, and specific food components. From a consumer perspective it also means addressing personal and cultural values, ranging from taste preferences to environmental issues. Moving from an individual to a broader social context brings industry into perspective, as the provider of food. This review considers the case of chicken and the health of Australians, and, in moving through the various perspectives, addresses the question: where does chicken fit?

CHICKEN, HEALTH AND DIETARY PATTERNS

The links between health and dietary patterns are studied by various means, with intervention studies providing the highest level of evidence for dietary recommendations. Food choice remains at the heart of the research, but the focus can shift from a positive stance (ensuring adequate nutrition) to a negative one (reducing disease risk). Obesity is arguably the most significant food related health issue for Australians today. Overweight and obesity are major predisposing factors for diseases such as diabetes, hypertension, coronary heart disease and certain forms of cancer [1]. Management of overweight, especially before the development of these complications, is particularly relevant for Australians, with more than half of the adult population [2] and over a fifth of children aged 5–17 years being overweight or obese [3].

THE ROLE OF CHICKEN IN HEALTHY DIETS

Chicken delivers important nutrients

Lean chicken meat is an excellent source of protein, has a favourable ratio of unsaturated to saturated fatty acids and delivers essential vitamins and minerals. The health impact of chicken is linked to its nutritional composition and the interactions of those nutrients within the food. The nutrient composition of stir-fried chicken breast meat is compared with stir-fried cuts of other meats in Table 1. Furthermore, the nutrient composition of different cuts of lean Australian chicken meat, raw and cooked, is shown in Appendix 1.

Compared to other meat sources, stir-fried lean chicken breast has the lowest total fat content. The type of fatty acids contributing to this total fat profile should be noted. Stir-fried lean chicken breast contains more than 55% unsaturated fatty acids (monounsaturated and polyunsaturated) and one of the lowest levels of saturated fatty acid when compared with other stir-fried meat sources. Stir-fried chicken breast also appears to be higher in a number of micronutrients, although removal of the skin from the meat reduces these figures considerably. Stir-fried lean chicken breast is an excellent source of niacin equivalents, providing higher amounts than each of the other lean stir-fry cuts of meat. For other macro- and micronutrients, stir-fried lean chicken breast has a similar nutrient profile to lean stir-fried cuts of beef, lamb, pork and veal [4], although it contains relatively little iron and less zinc than the cuts of beef, lamb, pork and veal used in this comparison.

The nutrient profile of chicken meat has been shown to be amenable to manipulation by different feeding practices. For example, dietary supplements such as garlic, copper, omega-3 fatty acids and dehydrated alfalfa have been used in an attempt to change the fat and cholesterol content of poultry meat [5-9]. It is possible to change the fatty acid profile of chicken meat to increase its omega-3 fatty acid content by feeding chickens either linseed or rapeseed grain extract (tenfold increase in alpha-linoleic acid, ALA), or fish extract or algae oils (seven-fold increase in long chain docosahexaenoic acid, DHA) [10].

Such innovations in the production system may further increase the potential benefits of chicken meat in the diet in years to come. The nutrient composition of Australian chicken meat is also affected to some extent by the type (breed) of chicken, butchering technique (for example, the amount of trim), age and sex of the bird.

At present there appears to be no conclusive body of data demonstrating significant differences between the nutritional composition of conventional, organic, free-range and kosher chicken meat.

Chicken contributes to nutrient requirements

To establish how chicken can contribute nutritionally in the context of a whole diet, the nutritional values for a serve of chicken meat can be compared with the recommended dietary intakes of Australians [11]. When this was done for all age groups and for both genders, baked lean chicken breast alone was found to provide

between 110 and 147% of daily niacin requirements (Table 2; with Appendix 2 providing further information regarding each of the main chicken cuts). Lean chicken breast was also found to be an important source of protein, providing more than 50% of the recommended dietary intake (RDI) for all ages except 14-18 year old males who have higher protein requirements. For pre-pubescent children, lean chicken breast is a good source of magnesium (11.5-18.8%) and zinc (10-13.3%), and provides reasonable amounts of riboflavin (9.2-12.2%).

Thus, from a nutritional perspective, chicken can fulfil a valuable role in the Australian diet. Lean chicken meat is a good source of protein, and its high protein content may support efforts at weight management. It is also a low cholesterol meat choice that contains essential fatty acids and is a source of minerals and essential vitamins, particularly vitamin E, vitamin A equivalents and thiamin, and delivers significant amounts of niacin equivalents, an important nutrient for energy metabolism [11].

Review of research on potential health benefits

An initial literature search conducted in PubMed using the search terms "chicken and health" identified 361 abstracts. Of these, most were not related to health benefits of chicken in humans, but referred to topics such as bacterial contamination and microbiological safety (n=84 abstracts), parasites, viral agents and environmental toxins (n=35), avian influenza (n=37), livestock production (n=28), food security and food choices (n=36), food safety and food handling (n=17), chicken eggs (n=13), embryonic development (n=8), while the majority were not related to chicken per se (n=84). Only 19 abstracts were selected from this search and six full papers included in the review. The search was then refined to include the terms "chicken intake" and "health or diabetes or cancer or obesity or weight control or cholesterol or cardiovascular disease." This strategy identified 101 abstracts of which 46 were selected, and N=32 full papers included in the review. A summary of the papers is shown in Appendix 3.

Research published in the scientific literature between 1996 and 2007 relating to the potential health benefits of chicken meat identified that major research activity relates to the role of chicken in weight loss and reduction of cardiovascular risk factors as well as the chicken consumption and risk of cancer, particularly colorectal cancer.

Weight loss and cardiovascular disease risk factors

High protein diets have proven effective in weight loss, both in the short [12-14] and longer term [15-17], suggesting a role for foods that deliver high quantities of protein, such as chicken.

Two studies examining the specific effect of chicken on weight loss were identified by the current literature search. Both studies were randomized controlled trials of high quality and validity. In one study of 54 postmenopausal women comparing hypocaloric diets of high protein (provided mainly by chicken or beef) and high carbohydrate diets, a similar reduction in mean energy intake was achieved between the groups over nine weeks [18].

Table 1: Nutrient composition of stir-fried (cooked) lean chicken breast meat compared with stir-fried cuts of beef, lamb, pork and veal. Based on 100g serve

		Chicken breast**	Beef stir-fry strips*	Trim lamb stir-fry strips**	Pork leg strips*	Veal stir-fry strips**
Energy	kJ	520.00	644.00	770.00	557.00	620.00
Total Protein	g	28.60	30.90	28.00	29.50	29.90
Total fat***	g	0.90	3.20	7.90	1.50	3.00
Total SFA[a]	g	0.30	1.00	2.80	0.60	1.20
Total MUFA[b]	g	0.40	1.40	3.10	0.60	0.90
Total PUFA[c]	g	0.10	0.40	0.90	0.20	0.50
C18:2 n–6 (linoleic acid)	g	0.11	0.15	0.46	0.15	0.18
C18:2 n–3 (alpha-linolenic acid)	g	0.01	0.03	0.14	0.01	0.04
C22:6 n–3 (docosahexanoic acid)	mg	3.00	8.00	25.00	3.00	15.00
Cholesterol	mg	62.00	77.00	96.00	70.00	99.00
Vitamin E[d]	mg	0.50	0.70	0.20	0.00	0.30
Vitamin A[e]	μg	5.00	2.00	8.00	0.00	2.00
Iron	mg	0.40	2.80	3.70	1.00	2.10
Magnesium	mg	33.0	23.00	27.00	27.00	37.00
Niacin equivalents	mg	20.60	9.40	11.80	12.10	15.10
Riboflavin	mg	0.09	0.11	0.34	0.26	0.20
Thiamin	mg	0.12	0.03	0.15	0.96	0.10
Zinc	mg	0.70	7.20	2.60	2.40	5.80

[a] Saturated fatty acids, [b] Monounsaturated fatty acids, [c] Polyunsaturated fatty acids, [d] Alpha-tocopherol equivalents, [e] Retinol equivalents. Data sourced from NUTTAB 2006 online [4]
*Separable lean, **Lean, ***Total fat ≠ SFA + MUFA + PUFA; this may be the result of not including meat juices from the cooking in the chemical analysis and rounding factors.

Table 2: Percentage contribution of 100g lean baked chicken breast to nutrient requirements for Australians [11] (50g portion in the case of children up to the age of 8)

	All		Males				Females							
Nutrient	1-3yrs[a]	4-8yrs[a]	9-13yrs	14-18yrs	19-70yrs	>70 yrs	9-13yrs	14-18yrs	19-70yrs	19-30yrs	31-70yrs	19-50yrs	51-70yrs	>70yrs
Total protein [b]	103.71	72.60	72.60	44.68	45.38	35.85	82.97	64.53	63.13					50.95
Essential fatty acids														
Linoleic acid (omega 6) [c]	4.84	3.03	4.84	4.03	3.72	3.72	6.05	6.05	6.05					6.05
Alpha-linolenic acid (omega 3) [c]	3.50	2.19	3.50	2.92	2.69	2.69	4.38	4.38	4.38					4.38
Minerals														
Potassium [c]	8.00	6.96	10.67	8.89	8.42	8.42	12.80	12.31	11.43					11.43
Magnesium [b]	18.75	11.54	12.50	7.32	7.50 [a] 7.14 [b]	7.14	12.50	8.33		9.68 [d]	9.38 [e]			9.38
Iron [b]	2.78	2.5	6.25	4.55	6.25	6.25	6.25	3.33				2.78 [f]	6.25 [g]	6.25
Zinc [b]	13.33	10.00	13.33	5.71	5.71	5.71	13.33	11.43	10.00					10.00
Vitamins														
Vitamin E [c,h]	2.20	1.84	2.44	2.20	2.20	2.20	2.75	2.75	3.14					3.14
Niacin equivalents [b]	147.50	110.63	147.50	110.63	110.63	110.63	147.50	126.43	126.43					126.43
Riboflavin [b]	11.00	9.17	12.22	8.46	8.46	6.88	12.22	10.00	10.00					8.46
Thiamin [b]	5.00	4.17	5.56	4.17	4.17	4.17	5.56	4.55	4.55					4.55

[a] 50g portion, [b] Recommended Dietary Intake (RDI), [c] Adequate intake (AI), [d] 19-30, [e] 31-70 years, [f] 19-50 years, [g] 51-70 years, [h] Alpha-tocopherol equivalents

Here, the chicken diet (but not the beef diet) showed a significantly higher weight and body mass index loss than the high carbohydrate diet ((representing losses of 7.9 (SD = 2.6) and 5.6 (1.8)kg respectively (P<0.05)). However, the weight loss was not statistically different between the chicken and beef diet groups. These findings were confirmed in a similar 12-week study in which weight loss did not differ according to allocation to a diet where the predominant protein source was either lean beef or chicken [19]. This group concluded that weight loss and improved lipid profile effects were best achieved by high dietary protein regardless of the comparative food source. Anecdotally, red meat is often perceived to be more filling than white meat (chicken and fish). However, an older appetite study also supports the finding of a lack of difference by demonstrating that the postprandial satiety response to either beef or chicken did not differ [20].

Chicken has a role, within the context of a low fat eating plan, in cholesterol-lowering diets. Incorporation of either chicken, lean beef or lean fish in an American Heart Association diet showed that plasma total and LDL cholesterol can be reduced by 7–9% over a short period of time (26 days) in hypercholesterolaemic men, irrespective of the protein source [21]. These findings confirm the findings of earlier research [22].

Whole dietary models are also of interest in determining the position of individual foods in protecting cardiovascular health. The DASH diet, for example, has been shown to be effective in lowering blood pressure, particularly in people with hypertension and in African Americans [23]. This diet emphasises chicken and fish, and includes nuts and low-fat dairy products, alongside high proportions of fruits and vegetables.

From a more general perspective, further information on the position of individual foods can be considered in terms of other dietary relationships. In a large US cross-sectional survey of children (n=4,802) and adults (n=9,460), for example, the inclusion of an average intake of less than 28g of chicken over two days was associated with lower discretionary fat intakes compared to non-consumers or consumers of larger portions (≥28g

cooked lean chicken equivalent per two days) [24] ($P<0.05$). This highlights the importance of portion size, a key component of guidance on food choice.

Chicken and cancer risk

In 2007, the World Cancer Research Fund (WCRF) published a recommendation that intake of red meat (beef, pork, lamb and goat) should be limited, and in those who consume red meat, less than 500g a week is the dietary target [34]. WCRF also recommended that processed meats should be avoided. Links between diet and cancer are difficult to ascertain because by nature there is a reliance on associations reported in observational studies. The WCRF report determined that the evidence was too limited in amount, consistency or quality to draw any conclusions regarding poultry consumption and cancer risk [25]. A brief indication of why this is the case can be seen from a summary of published studies (accessed on PubMed) in the period 1996-2007 (see Table 3).

Of seven papers identified in a systematic search on colorectal cancer risk, five found a protective association with increased chicken consumption [26-30], one found no association [31], while another found a positive association between cooking method for chicken (i.e. preferring darkly browned surfaces) and cancer risk [32]. For breast cancer, increased chicken consumption was either associated with no additional risk [33] [34] or was found to be protective [35] [36], regardless of cooking method [37]. One case-control study found that postmenopausal women with oestrogen receptor-positive tumours were more likely to consume a dietary pattern that included chicken, along with other foods, than controls without cancer [38]. For bladder cancer, an increased risk was associated with skinless chicken consumption of more than five times per week, but this was not found for chicken consumed with skin [39]. It was hypothesised that chicken without skin contains more heterocyclic amines than chicken cooked with skin. A large prospective cohort study (N=110,792) from Japan found a significant inverse association between hepatocellular mortality and chicken consumption in men [40], and another case-control study from China also reported protective effects of chicken consumption on hepatocellular cancer risk [41]. Two studies on gastric cancer found either a decreased mortality risk associated with chicken intake [42] or no association between chicken intake, including cooking method, and risk of adenocarcinoma of the stomach and oesophagus [43]. No association has been shown in a study investigating chicken consumption and ovarian cancer risk [44].

Despite a number of studies suggesting some protective effects of chicken meat against cancer, the overall evidence is not conclusive.

There is emerging evidence that the cooking method of meat is possibly more important than frequency of consumption of specific foods in determining risk of various cancers. In a study of pancreatic cancer risk, more cases than controls showed a preference to well-done meats, including bacon, grilled and pan-fried chicken [45]. Similarly, Norrish [46] and colleagues reported a weak and inconsistent association between meat doneness and increased risk of prostate cancer, but this was not significant for chicken. Thus while there is no conclusive evidence linking chicken meat with cancer or its prevention, cooking methods that generate carcinogenic compounds such as heterocyclic amines (HCA) and polycyclic hydrocarbons (produced when meats are cooked over an open flame or charred) deserve some attention. Reduced levels of HCA have been found in chicken that has been marinated before grilling [47]. Meats (beef patties) that are partially cooked in a microwave oven before being cooked by higher temperature methods also have lower levels of these compounds [48]. A review by Thomson [49] reported that the most important variables contributing to HCA formation are: cooking temperature (>150°C), cooking time (>2 min), cooking method (frying, oven grilling/broiling, barbecuing), and meat type. However, much of the evidence relating to the formation of HCAs and polycyclic hydrocarbons in various meats prepared using different cooking methods is inconsistent and reported absolute amounts of these compounds are highly variable between studies. Undoubtedly, further well-controlled studies are required to inform consumers of the best way to prepare meat in order to minimise health risks.

Table 3: Summary evidence table of studies identified in PubMed (1996–2007) on chicken and health

Health outcome	Study	In support of association?	Quality of study	Type of study/Comments	Classification of evidence
Weight loss	Mahon et al., 2007	No	High	RCT. Chicken vs. beef vs. CHO	Insufficient evidence
	Melanson et al., 2003	No	High	RCT. Chicken vs. beef; no control group	
Cancer					
Colorectal cancer	Sato et al., 2006	No association	High	Cohort study	Insufficient evidence
	Hu et al., 2007	Protective for chicken intake in men only	High	Case-control study	
	Navarro et al., 2004	Increased risk for chicken according to cooking method	Medium	Case-control study	
	Chiu et al., 2004	Decreased risk for chicken/turkey intake	Medium	Case-control study	
	Le Marchand et al., 1997	Decreased risk for chicken/turkey intake without skin	Medium	Case-control study	
	Phinney, 1996	Decreased risk for chicken intake	Medium	Review of epidemiological studies	
	Robertson et al., 2005	Decreased risk for chicken intake	High	Secondary analysis of dietary data in RCTs (cross-sectional)	
Pancreatic cancer	Li et al., 2007	Increased risk with increasing HCAs from meat, including chicken	Medium	Case-control study	Insufficient evidence
Breast cancer	Cui et al., 2007	Increased risk associated with chicken as part of "meat-sweet" pattern (shrimp, chicken, beef, pork, candy, desserts), but only in postmenopausal women with estrogen receptor-positive tumours	Medium	Case-control study	Insufficient evidence
	Delfino et al., 2000	Decreased risk for chicken intake, including well done, pan fried and barbecued chicken	Medium	Case-control study	
	Gertig et al., 1999	No risk associated with increased frequency of chicken intake	Medium-high	Case-control study	
	Ambrosone (30)et al., 1998	Decreased risk with higher poultry consumption in post-menopausal women only	Medium-high	Case-control study	
	Potischman et al., 1998	Slight increase (borderline significance) in risk for intake of chicken	High	Case-control study	
	Djuric et al., 1998	Suggests inverse association between poultry intake and oxidative DNA damage.	Low	Cross sectional survey	
Bladder cancer	Michaud et al., 2006	Elevated risks with chicken consumption without skin ≥ 5 times/wk compared to non-consumers of skinless. No associations for chicken with skin	High	Two large cohort studies	Probable evidence
Hepatcellular cancer (liver)	Kurozawa et al., 2004	Decreased risk in men without history of liver diseases. but not women (no risk)	High	Cohort study	Insufficient evidence
	Yu et al., 2002	Decreased risk	Could not obtain paper	Case-control study	
Ovarian cancer	Pan et al., 2004	No association of risk with chicken intake.	Medium	Case-control study	Insufficient evidence
Gastric cancer	Huang et al., 2000	Decreased mortality risk with chicken intake	Medium	Prospective prognostic study	Insufficient evidence
	Ward et al., 1997	Broiling or frying not associated with risk; too few data for roasted/BBQ chicken	Medium-low	Case-control study	
HCA intake and chicken	Bogen et al., 2007	PhIP intake attributable mostly to chicken. Increased risk for PhIP intake and highly elevated PSA	High	Clinic based cohort study (prostate cancer biomarker not disease outcome)	Insufficient evidence
	Knize et al., 2002	Higher excretion of PhIP metabolites from chicken after broccoli consumption, implying cancer protective effect of broccoli.	Low	Quasi-experimental	
	Thomson, 1999	BBQ chicken provided highest concentration of PhIP of all meats, but variable levels according to cooking method.	Medium	Review	
	Wong et al., 2005	Pan-fried and deep-fried chicken contributed significantly to HCA intake.	High	Cross-sectional	
	Byrne et al., 1998	Large variation in HCA intake	Low	Cross-sectional analysis of cohort dietary data	
Cardiovascular outcomes	Pala et al., 2006	Chicken consumption (included in "olive oil and salad" eating pattern) highest in hyper-lipidaemic and suggesting awareness of the (beneficial) dieting subjects, health consequences of these patterns	High	Cohort study	Insufficient evidence
	Sacks et al., 1999	DASH study which includes chicken reduces blood pressure	High	Mulitcentre randomised controlled parallel group feeding trial.	
	Sperber et al., 1996	Increased chicken consumption associated with total cholesterol decrease at community level	Low	2-year quasi-experimental study	
Immunity	Brian et al., 2006	Declines in interleukin-2 production with a chicken diet; the clinical significance of this finding is not known.	High	Randomised controlled trial	Insufficient evidence

FOOD SAFETY IS AN IMPORTANT CONSIDERATION

Safe food handling is a concern for all foods. From 1995 through 2000, 214 outbreaks of food borne disease were identified in Australia, affecting a total of 8,124 people [50]. Seventy-four of these outbreaks, involving 6,472 people, had a known aetiology. Bacterial disease was responsible for 61% of the outbreaks, with *Salmonella* being the most common pathogen (35% of outbreaks), followed by *Clostridium perfringens* (14%), ciguatera toxin (11%), scombrotoxin (3%) and norovirus (3%). There were 20 deaths attributed to food borne illness; salmonellosis and listeriosis were each responsible for eight (40%) of the deaths. Restaurants and commercial caterers were associated with the highest number of outbreak reports and cases, followed by hospitals and aged care facilities. The most frequently implicated vehicles in the 173 outbreaks with known vehicles were meats (30%), fish (16%), seafood (6%), salad (6%), sandwiches (5%) and eggs (4%). Chicken, the most frequently implicated meat, was associated with 27 (13%) of the outbreaks.

Food safety risks can be minimised by following some basic storage, preparation and cooking practices [51], as bacteria can become a problem if food is not stored and handled correctly. Chicken meat is a 'perishable' food, and therefore should not be kept at room temperature for more than two hours. Raw meats should be stored at a maximum temperature of 4°C or kept frozen below -15°C. Frozen chicken meat should always be thawed completely prior to cooking. Separate utensils should be used in preparation and cooking should ensure 75°C at the centre of the thickest part of the meat, producing clear juice at the end. Stuffing should be inserted loosely before, and removed immediately after cooking.

Chicken that is to be kept hot should be kept above 60°C and leftovers should be stored in the fridge for one to two days only or be frozen. Leftovers should be heated to at least 70°C for a minimum of two minutes. Although listeriosis is not rated a significant risk from chicken meat [52], in pregnancy chicken is best consumed hot immediately after cooking, and any leftovers stored in the fridge and used within a day of cooking or purchase [53].

INDUSTRY FACTS

Food safety and chicken

Food safety is paramount to both healthy eating and consumer confidence. The chicken meat industry participates in research and tracks best practice in animal husbandry and food handling with the aim of improving food safety. Through its participation in the government's Rural Industries Research and Development Corporation, industry is active in developing research strategies and priorities and funding research and development to address food safety issues.

Campylobacter and Salmonella are food-borne bacterial pathogens that can be found on chicken meat and are a potential risk with all types of meat. Any risk from these bacteria is completely eliminated if meat is cooked properly and care is taken not to contaminate other cooked foods or those to be eaten raw, such as salad.

On farm, sound husbandry practices in collecting, transporting and handling birds enhance both bird health and welfare and food safety for consumers.

During processing, audited quality assurance programs which identify and manage risk in food handling, such as the internationally recognised HACCP and quality assurance programs run by major chicken processors, help ensure consistency and high standards.

For consumers, industry supports communication initiatives to encourage safe food handling in the home, as well as providing information directly to consumers.

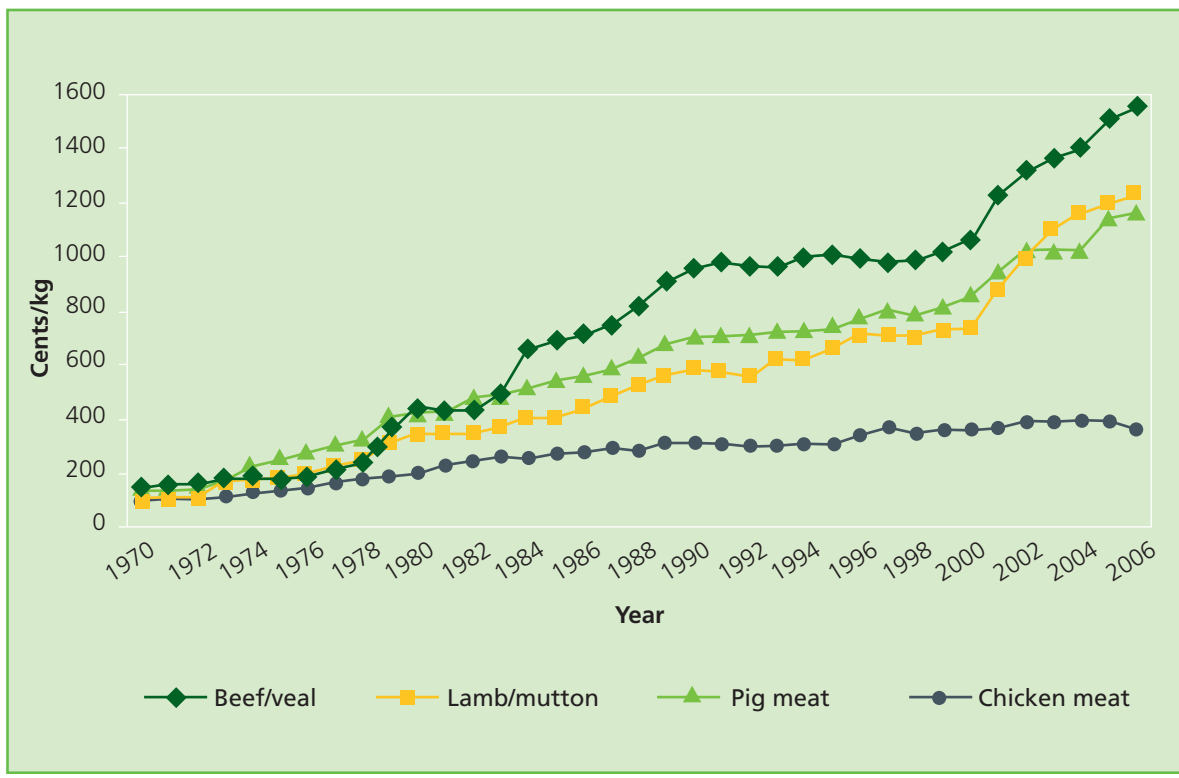
CONSUMER PERSPECTIVES ON CHICKEN

When it comes to meat, qualitative studies have found that freshness, sensory factors and perceived 'healthfulness' are the most important drivers of product choice [54]. Poultry tends to be perceived more favourably than beef or pork in terms of these attributes [54]. In Australia, producer efficiency has helped to keep wholesale prices low and some observers credit the success of chicken relative to other meats to its affordability. While the retail cost of beef, lamb and pork has steadily increased, particularly since 2000, the cost of chicken has remained remarkably stable (Figure 1) [55].

and, above all, chicken is versatile, which extended to its acceptance by vegetarian family members. Chicken is perceived as a particularly 'family friendly' food which contributes to easing the pressures on the family cook [56].

With increasing time pressures due to longer working hours and more women in the workforce, consumer demand for highly processed and convenience goods has driven chicken meat to be rapidly absorbed by the value-adding sector of the food industry, more so than other meats [57].

Figure 1: Retail prices of meat in Australia, 1970 – 2006 Source: Australian Bureau of Agricultural and Resource Economics, ABARE Australian Commodity Statistics, 2007 [55]



However, Dixon [56] argues that the reasons for the popularity of chicken are far more complex than being merely a pricing issue. Her focus group research showed that chicken is held in high esteem by Australian consumers. Among the explanations provided were: a personal liking of chicken meals; it is healthier than red meat; it is easy to prepare and easy to chew, which was a particularly important attribute with children;

The success of chicken meat with consumers also appears to be determined by its health image [54]. Compared to other meat types, chicken is perceived as healthier in terms of fat content and is considered to be a lean, low-fat food, particularly in the case of chicken breast fillets [58]. Consumers perceive that leanness of chicken meat can be assessed when purchasing it raw, enabling any skin or extraneous fat to be removed prior to cooking.

Chicken consumption also appeared to be motivated by a perceived need for weight loss. Australian consumers often express concerns about the chicken industry relating to their perception that growth hormones are used (whereas no hormones whatsoever are used in chicken meat production in Australia) and the conditions under which chickens are grown [56], with free range systems being seen as a more animal welfare friendly farming method.

These concerns are often enhanced by the misconception that meat chickens are raised in cages, which has never been the case.

INDUSTRY FACTS

Busting the myths behind today's chicken

Through generations of selective breeding and careful attention to optimal nutrition, today's meat chickens are a faster growing, larger and stronger bird.

No added hormones – hormones are not administered in any form; the use of added hormones in growing chickens in Australia has been banned for many decades.

Responsible use of antibiotics – antibiotics are used to prevent and treat disease and their use is carefully managed to minimise the development of resistance and to ensure that no residues are detectable in meat (i.e. any residue level must be below the very low level set in the Australian Standards published in the Australia New Zealand Food Standards Code). While some antibiotics used in human medicine are used to treat ill birds, antibiotics important to human health are not used for routine disease prevention. In addition, avoparcin and vancomycin, two antibiotics which have been identified as of particular concern in terms of antibiotic resistance development, are never used by the Australian chicken meat industry.

No cages – Meat chickens live on the floor of large sheds – they are never caged.

Organic and free range production – Free range and organic chickens are also housed in sheds but may also roam outside the shed for part of the day. Organic and free range chickens are not given antibiotics (i.e. birds that require antibiotic treatment can no longer be sold as free range or organic) and organic chickens are only given feed which has not been treated with agricultural chemicals.

Australian grown – Except for a small amount of fully cooked tinned or retorted product, all chicken eaten in Australia is grown in Australia.

Chickens for egg production – these are quite different birds to those raised for meat due to different breeding priorities. The egg industry operates as a separate industry with different production systems.

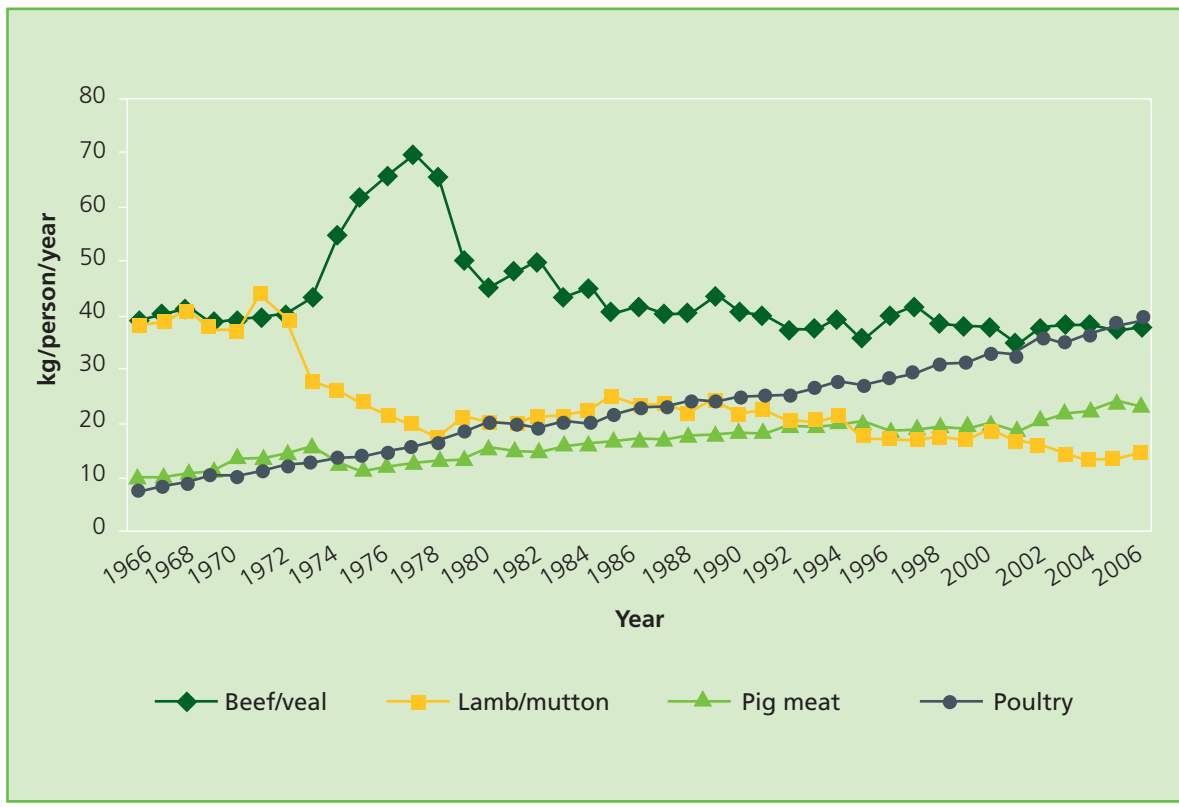
Consumers are choosing more chicken

Over the past 40 years chicken consumption has increased, elevating chicken meat from a position of marginal importance in Australian diets to rivalling beef as Australian consumers' favourite meat choice. The main changes in consumer preferences for meat sources of protein relate to an increased consumption of poultry and a gradual fall in consumption of sheep meat and beef [58] (Figure 2).

Australia is now one of the highest per capita consumers of chicken meat in the world [59]. In 2006, per person consumption of chicken meat was estimated by the ACMF to be 37.4kg, based on ABARE's poultry production statistics [55].

As well as an increased consumption of chicken in the Australian diet, there is a change in consumer demand regarding the type of chicken product. There is a rapid shift away from unprocessed raw chicken towards value-added products and cooked chicken products [60].

Figure 2: Consumption trends of poultry and other meats in Australia, 1966–2006 Source: Australian Bureau of Agricultural and Resource Economics, ABARE Australian Commodity Statistics, 2007 [55].



THE AUSTRALIAN CHICKEN MEAT INDUSTRY

It is thought that intensive poultry production began in the 1950s, although records only date back to the mid 1960's. Chicken meat production in Australia is a highly intensive industry; chickens are raised in large sheds which provide the birds with a stable environment protected from the elements; no meat chickens are grown in cages. The chicken meat industry is an important contributor to the national economy, with a Gross Value of Production (GVP) of $1.442 billion in 2006/07 [55].

The Australian Chicken Meat Federation [62] estimates that Australian consumers spend around $4.4 billion on chicken meat per annum. Australian chicken meat production was estimated to be 816,166 tonnes for 2007 [63]. The Australian chicken meat industry has experienced rapid growth over past decades[61]. Trends in chicken meat production [63] show a ten-fold increase between 1967 and 2007 (see Table 4).

Most chicken meat produced in Australia is consumed locally. Under Australian quarantine regulations, raw chicken meat cannot be imported. While importation of cooked chicken meat is permitted under very strict conditions and cooking protocols from a small number of countries, in practice importation of cooked chicken meat products is virtually zero [64].

Table 4: Trends in chicken meat production, poultry consumption and price of chicken meat in Australia

Year	Chicken meat produced (tonnes carcass weight/year)[a]	Consumption of poultry meat (kg/person/year)*[b]	Price (cents/kg chicken meat)[b]
1967	82,540	8.4	Not available
1977	205,524	15.6	174.5
1987	354,633	23.2	288.6
1997	512,244	29.3	365.9
2006		39.5†	357.1†
2007	816,166#		

* Chicken meat constitutes approx. 94.6% of all poultry meat (ACMF)

\# 2007 figures

† 2006 figures (2007 figures not available at time of publication)

[a] Chicken meat production statistics are sourced from the Australian Bureau of Statistics (ABS) Publication "Livestock Products, Australia" Catalogue No 7215.0 [63].

[b] Consumption and Price statistics are extracted from Australian Bureau of Agricultural and Resource Economics, ABARE Australian Commodity Statistics, 2007. Price estimates are formed by indexing forward from actual average prices of beef, lamb, mutton, pork and chicken during December quarter 1973, based on meat subgroup indexes of the consumer price index. These indexes are based on average retail prices of selected cuts (weighted by expenditure) in state capitals.

PRODUCTION SYSTEMS ARE SENSITIVE TO ENVIRONMENTAL ISSUES

Nutrient efficiency is regarded as an important criterion to describe the sustainability and the environmental impact of animal production systems [65]. The efficiency in converting feed into meat is commonly expressed as the feed conversion ratio (FCR). Simply expressed, this is the kilograms of feed consumed to produce one kilogram of live weight.

Through careful breeding and selection processes (90% of the improvement) and improved nutrition (10% of the improvement) the chicken meat industry has made great strides in improving the feed conversion ratio [66]. Compared to chicken meat production in 1957, a bird reared in 2001 required approximately one-third of the time (32 vs. 101 days) and less than one third of the amount of feed (FCR of 1.47 vs. 4.42) to reach a weight of 1.85kg [66].

While there are many ways of measuring environmental impact, two means – nutrient balance and life cycle assessment (LCA) – have emerged in recent times as methods of choice [67] [68]. Nutrient balance studies have shown that the nutrient gain in birds per unit of nutrient intake (i.e. the retention of nutrients) is higher for intensive poultry production than for free range and organic production systems [65]. LCA analyses a production system in a systematic manner – accounting for all inputs and outputs that cross the specified system boundary [68]. LCA has been extensively used in industrial processes but can be useful when applied appropriately to agricultural systems [68]. An LCA study of animal production systems in England and Wales has shown that poultry production is more environmentally efficient than pig, sheep and beef production systems [68]. The greater environmental efficiency of poultry production systems is attributed to the low overheads of poultry breeding (each hen produces around 250 progeny per year), the very efficient feed conversion of broilers and the high daily weight gain of the broiler. An LCA study of agricultural production systems in the US also demonstrated that chicken meat is the most energy and water efficient land-based animal protein production system [69].

There is considerable research investment devoted to ensuring that nutrients provided in the feed of meat chickens are at levels that are not only beneficial for the chicken, but that are not likely to cause environmental problems when poultry manure or litter is applied to agricultural land. For example, phosphorous is a key mineral in animal feeds[70], however excess phosphorous in the environment can potentially be transported to aquatic systems and cause problems such as excessive plant growth, reduction in oxygen levels and fish die-offs [71]. The use of phytase enzymes in broiler diets reduces the need for supplemental phosphorous by around 15% [72] [73]. Similarly, research has shown that the use of highly bioavailable mineral proteinates, as opposed to inorganic salts, as a source of trace minerals [74] allows a major reduction in supplementation levels of minerals such as zinc. The research has shown that the reductions may be as high as 80% with no adverse consequences on the health, welfare or growth of the broilers [74].

The Australian chicken meat industry is committed to both maintaining and improving the environmental footprint of the industry, as demonstrated at several levels (Box 1).

INDUSTRY FACTS

What are the main differences between conventional, certified free-range and certified organic chicken?

All meat chickens, be they conventional, free range or organic, are raised in barns where they live on the floor, not in cages.

Free range chickens have to have access to an outdoor space during the day once they reach 3 weeks of age. They cannot be treated with antibiotics. They have more space available per bird than at conventional chicken farms. They are the same strain of chicken than used in conventional production and they are fed the same feed. They are 35 to 55 days old when harvested, the same age as conventionally raised chickens.

Organic chickens are fed only organic feed (no synthetic fertiliser, herbicide or pesticide used in its production). They are given access to an outdoor space during the day after 10 days of age. They cannot be treated with antibiotics. They are provided with more space than conventional and free range chickens. They grow more slowly and are between 65 and 80 days old when harvested.

Box 1- Industry commitment to maintaining and improving the environmental footprint of the chicken meat industry

- At the producer level, the industry has been pro-active in identifying opportunities for improving the eco-efficiency of the industry. For example, the Queensland Chicken Growers Association has been a partner, along with the Queensland Environmental Protection Agency and the UNEP Working Group for Cleaner Production, in a project that has identified potential savings in lighting, ventilation, heating and water use [75]. In Victoria, chicken meat growers have, in partnership with the Victorian Department of State and Regional Development and the Mornington Peninsula Shire Council, developed the Chicken Care Program – a comprehensive program which amongst other activities has identified best practices in environmental management and provided tools to assist in the implementation of these best practices [76].

- At the national level, the industry has a National Environmental Management System that comprises a detailed Manual of Good Environmental Practice and tools to enable the development of a farm-specific Environmental Management Plan [77].

- Research investment of the industry is facilitated through two research mechanisms – The Rural Industries Research and Development Corporation (RIRDC) Chicken Meat Program (http://www.rirdc.gov.au/programs/cm.html) and the Australian Poultry CRC (http://www.poultrycrc.com.au).

  The Poultry CRC has a major sub-program of research on the impact of poultry production on the environment - specifically developing strategies to ensure that dust and odour emissions are managed appropriately. The RIRDC Chicken Meat Program has a major focus on ensuring that litter is recognised as a valuable by-product that can be used in a safe and sustainable manner.

CONCLUSION

Perhaps more then ever today, consumers need to be able to discriminate between foods based on health and wellbeing values. This review has shown that chicken is an excellent source of protein, low in fat and is nutrient dense. Nutrient dense protein foods are important in Australian diets today, not only for growth and development, but possibly also in weight management. As with similar foods, safe handling is important, but chicken is easy to prepare and liked by consumers. The Australian chicken meat industry has experienced rapid growth over the past forty years and continues to invest in research to ensure production systems work with greatest environmental efficiency. These positive attributes will ensure that chicken maintains its strong position in the Australian diet, supporting the health and wellbeing of Australian families.

INDUSTRY FACTS

Avian influenza – it's not in your food

Two very different diseases are often referred to as avian influenza (or bird flu) – a 'real' one which infects chickens and other birds (and only on very rare occasions infects humans), and a 'hypothetical' human disease which is more correctly referred to as a human influenza pandemic.

Bird disease: In recent years a highly pathogenic strain, H5N1, has spread widely among poultry in Asia and some other countries, but not in Australia. While it has infected a small number of humans under exceptional circumstances, it is not easily transmitted between humans. The likelihood of an outbreak of this strain of avian influenza in Australian poultry is extremely low. Furthermore, a high level of preparedness and past experience with AI outbreaks provide confidence that should the H5N1 strain, or any other AI strain, get into a local flock, it would be identified and eradicated quickly.

In the event of an outbreak in Australian poultry, chicken meat from infected birds would not reach consumers. It is also reassuring to know that even if chicken meat was contaminated, the virus would be destroyed during normal cooking.

Human disease: There are concerns about a hypothetical human influenza pandemic, which may occur if an animal influenza virus mutates to one that transmits easily between humans. As humans would have very limited or no immunity to such a new strain it is anticipated that this could lead to a human influenza pandemic. At this point, it would no longer be a bird disease. A human influenza pandemic still remains a hypothetical risk; there is no evidence that the bird virus has mutated to a virus transmissible by humans at any time since the H5N1 virus emerged over 10 years ago.

There is only a remote possibility of a human pandemic influenza originating in Australia. International travel by infected people is the more likely route for the introduction of a hypothetical human pandemic influenza virus into Australia.

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