



Contents lists available at ScienceDirect

## Saudi Journal of Biological Sciences

journal homepage: [www.sciencedirect.com](http://www.sciencedirect.com)

## Review

## Animal cloning and consumption of its by-products: A scientific and Islamic perspectives

Mohd Izhar Ariff Mohd Kashim<sup>a,b,\*</sup>, Nur Asmadayana Hasim<sup>b</sup>, Diani Mardiana Mat Zin<sup>c</sup>, Latifah Amin<sup>b,d</sup>, Mohd Helmy Mokhtar<sup>e</sup>, Safiyah Shahimi<sup>f</sup>, Sahilah Abd. Mutalib<sup>f</sup><sup>a</sup> Center of Shariah, Faculty of Islamic Studies, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia<sup>b</sup> Institute of Islam Hadhari, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia<sup>c</sup> PERMATA Insan College, Universiti Sains Islam Malaysia, Bandar Baru Nilai, 71800 Nilai, Negeri Sembilan, Malaysia<sup>d</sup> Pusat Citra Universiti, Universiti Kebangsaan Malaysia, 43600 Bandar Baru Bangi, Malaysia<sup>e</sup> Department of Physiology, Faculty of Medicine, Universiti Kebangsaan Malaysia, 56000 Cheras, Kuala Lumpur, Malaysia<sup>f</sup> Department of Food Science, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia

## ARTICLE INFO

## Article history:

Received 23 April 2020

Revised 3 February 2021

Accepted 8 February 2021

Available online 18 February 2021

## Keywords:

Islam

Modern biotechnology

Animal cloning

Somatic Cell Nuclear Transfer (SCNT)

Food

## ABSTRACT

Islam is a religion that inspires its followers to seek knowledge continually and nurtures innovation, within the realms of Islamic rulings, towards an ameliorated quality of life. Up-to-date biotechnological techniques, specifically animal cloning, are involved in advancing society's health, social, and economic domains. The goal of animal cloning includes the production of genetically modified animal for human consumption. Therefore, this research endeavoured to study animal cloning's current scientific findings, examine the by-product of said process, and determine its permissibility in an Islamic context. This study employed descriptive literature reviews. Results concluded that animal cloning, especially in mammals, does not occur naturally as in plants. A broadly trusted and efficient animal cloning method is known as Somatic Cell Nuclear Transfer (SCNT), which includes three principal steps: oocyte enucleation; implantation of donor cells (or nucleus); and the activation of the embryo. Nevertheless, the limitations of SCNT, particularly to the Large Offspring Syndrome (LOS), should be noted. One of the forms of the application of animal cloning is in agriculture. From an Islamic perspective, determining the permissibility of consuming cloned animals as food is essentially based on whether the cloned animal conforms to Islamic law's principles and criteria. Islam interdicts animal cloning when it is executed without benefiting humans, religion, or society. Nonetheless, if it is done to preserve the livelihood and the needs of a community, then the process is deemed necessary and should be administered following the conditions outlined in Islam. Hence, the Islamic ruling for animal cloning is not rigid and varies proportionately with the current fatwa.

© 2021 The Author(s). Published by Elsevier B.V. on behalf of King Saud University. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## Contents

1. Introduction .....	2996
2. Animal cloning .....	2996
2.1. Natural cloning .....	2996
2.2. Somatic Cell Nuclear Transfer (SCNT) technique .....	2996

\* Corresponding author at: Center of Shariah, Faculty of Islamic Studies, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.

E-mail address: [izhar.ukm@gmail.com](mailto:izhar.ukm@gmail.com) (Mohd Izhar Ariff Mohd Kashim).

Peer review under responsibility of King Saud University.



<https://doi.org/10.1016/j.sjbs.2021.02.040>

1319-562X/© 2021 The Author(s). Published by Elsevier B.V. on behalf of King Saud University.

This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

3. The application of animal cloning in agriculture . . . . .	2997
4. Risk of the animal product derived from a cloned animal . . . . .	2997
5. Islamic perspective on animal cloning . . . . .	2997
5.1. The determination of the permissibility of food derived from cloned animals . . . . .	2998
6. Conclusion . . . . .	2999
Declaration of Competing Interest . . . . .	2999
Acknowledgement . . . . .	2999
References . . . . .	2999

## 1. Introduction

Islam urges one to seek knowledge and innovation to improve overall well-being and quality of life. Nevertheless, in recognising the sense of enhancing the quality of life, one must also ensure that their efforts comply with the Islamic rulings and not trigger adverse consequences, especially to humans. Modern biotechnology constitutes one of the key focuses of research in the last three decades. Since its conceptualisation, cloning has been a well-debated subject in addressing modern biotechnology issues in both the public and scientific fields (Larijani and Zahedi, 2004). The swift scientific advancement of animal cloning has garnered considerable attention, which led to critical consideration and review of the process (Fieger, 2005; Zin et al., 2019). Modern biotechnology applications can be broadly identified in genetics, medicine; bioremediation, human cell clones; Genetically Modified (GM) crops, GM food, and animal cloning. The first successful cloning was conducted by a group of scientists at Roslin Institute, Scotland, in 1995, using two sheep, Megan, and Morag.

The following year, the same group of scientists used adult stem cells to clone Dolly. Presently, scientists are not only cloning various species of animals, but these advanced scientific techniques are also used for genetic modification (GM) purposes, such that in the production of transgenic animals (Hasim et al., 2020). This process entails introducing a foreign gene into an animal’s genome to deliver desirable and economically significant characteristics in an animal. For instance, an experiment attended to produce a sheep that expresses a human gene resulted in the Factor IX protein in its milk, which can then be used to treat blood clots in humans with haemophilia (Ibtisham et al., 2017). Similarly, transgenic sheep are also made to produce *human alpha-1-antitrypsin*, which can treat emphysema diseases (McCreath, 2000). Other goals of cloning include the production of genetically modified animal organs to support human compatibility. Following the recognition of the numerous advantages of cloning and its capacity to serve various objectives, the agricultural sector has incorporated animal cloning into its practices to promote economic and environmental factors. Some typical transgenic methodology applications in agriculture comprise advanced milk production quality, improved disease resistance, and enhanced carcass composition to reduce environmental impacts (Isa, 2013). In attempts to reduce the environmental impacts, scientists are also producing featherless chickens to reduce overall farming costs and pigs with a lower amount of phosphorous in their faeces (Thomas, 2003). Scientists at Texas A&M University have also cloned a cow resistant to brucellosis (Phillips, 2002).

US Food and Drug Administration (FDA) conducted extensive assessments to evaluate cloned animal food products’ safety. It was shown that there is no difference in the composition of food products produced from animal clones and their offspring in terms of food safety relative to conventionally bred animals (FDA, 2008). Besides, a literature survey that analysed the composition, quality parameters, genotoxicity, and allergic reactions observed no differences in these parameters between meat or milk derived from cloned animals and their progeny from meat and milk of its non-

clone counterparts (Hur, 2017). No further evidence was shown that meat and milk from cloned animals pose a food safety risk. Thus, these findings were following the evaluations from the FDA.

The development of cloning technology has triggered severe concerns and garnered countless controversies surrounding ethical and religious perspectives (Isa, 2013). This study concentrated its arguments based on Islamic rulings, as it is the official religion of Malaysia. Allah SWT said: And We have not sent you, [O Muhammad], except as a mercy to the worlds (al-Anbiyaa’, 21:107). This verse symbolises that Islam was sent down as a mercy to humankind, supporting our understanding that the basis of Islamic rulings considers society’s interest (Samsudin et al., 2015; Hasim et al., 2016). Consequently, modern biotechnology’s commercialisation and utilisation are also essentially dependent on the public’s perception and approval of stated technology (Amin et al., 2009). This study analysed modern biotechnology, primarily about foods from cloned animals, in the scientific and Islamic context.

## 2. Animal cloning

### 2.1. Natural cloning

There are several methods of animal reproduction, including asexual and sexual reproduction. Asexual reproduction coexists with hermaphroditism and bisexual internal and external sex (Benagiano and Primiero, 2002). Animals may reproduce through asexual means by budding in jellyfish, coral reefs, tapeworms; fragmentation in worms; and parthenogenesis in fish, insects, frogs, and lizards. Most animals that reproduce asexually do so through parthenogenesis, which is triggered during specific conditions. Parthenogenesis is a more effective form of breeding than sexual reproduction, as it enables faster exploitation of available resources (Vajta and Gjerris, 2005). Nevertheless, mammalian asexual reproduction is not a naturally occurring phenomenon, despite the possibility of *monozygotic* twins (genetically identical) in mammals. *Monozygotic* twins are not considered clones as they are not the product of asexual breeding, and they differ from cloned animals, which only share the core DNA (different mitochondria) (Vajta and Gjerris, 2005). Hence, the cloning of animals, primarily livestock animals, is a relatively new phenomenon.

### 2.2. Somatic Cell Nuclear Transfer (SCNT) technique

Over the last 20 years, Somatic Cell Nuclear Transfer (SCNT) has become indispensable in stem cell research with considerable potential in producing SCNT cloned animals. This technique is widely used to produce cells and tissues that are immune-compatible to the somatic cell donor (Matoba and Zhang, 2018). SCNT appeared as brand-new biotechnology through which the possibilities derived from the advancements in molecular genetics and genome analysis in animal breeding. So far, more than 20 mammalian species have been cloned since the success of the first cloned mammal, Dolly the Sheep (Matoba and Zhang, 2018).

The SCNT technique entails three essential steps: oocyte enucleation, implanting donor cells (or nucleus); and the reconstructed embryo (Vajta and Gjerris, 2005; Niemann, 2016). The cloned embryos are cultured *in-vitro* for some time, and once at their optimal level, the embryos are then transferred into the 'parent' animal (Isa, 2013). In cloning, the nuclear genome (DNA) of a cell is replaced with another. The process is commenced by removing the maternal DNA from the mature oocyte, which is then replaced by the donor cell DNA (UNESCO, 2005). Somatic cells may be derived from the animal, from cells grown through culture media or frozen tissues (Committee on Science, Engineering and public policy, national academy of sciences, national academy of engineering, Institute of Medicine, 2002). A combination of chemicals is then introduced to prompt fertilisation, which results in the blastocyst stage. The derived embryo is then transferred or implanted into the uterus of an animal, followed by the natural process of pregnancy and birth (Isa, 2013).

Animals bred through natural sexual reproduction contrasts from cloned animals that are a by-product of a combination of two random genes (UNESCO, 2005). There are two possibilities. Firstly, if the ovum used is from the nucleus donor's mother, or the nucleus of the donor itself (Ayala, 2015). The resulting clone will hold the same genes (from the same nucleus and mitochondria) of the mother. The second possibility is if the ovum and nucleus used are from two distinct animals, or animals with different mothers. The resulting clone will then have a different gene as the genes are from differing mitochondria (Ibtisham et al., 2016).

The success rate of animal cloning carried out by scientists, is still mostly inconsistent, with results profoundly dependent on the species and the type of cells used in the process. SCNT performance is relatively low, with success rates of 0.3–1.7 per cent per reconstructed oocyte and 3.4–13 per cent per transferred SCNT embryo (Burgstaller and Brem, 2017). While complete nuclear transfer has been successfully cloned numerous mammals and has improved cloning performance, the proportion of cloned embryos that grow to full term remains poor, limiting the application of nuclear transfer technology (Czernik et al., 2019). Furthermore, the cloned foetus miscarriage commonly occurs with a significant increase in the risk of foetus abnormality or mortality. Even after birth, developmental abnormalities remain in cloned mammals (Loi et al., 2016).

The abnormalities and malformations resulted in the poor performance of SCNT that can be termed as the *Large Offspring Syndrome* (LOS), where the most commonly noted anomaly include the mismatch of size (cloned animals are too large for normal birth), as well as placental growth abnormalities (Harris, 1997; Ibtisham et al., 2017). LOS is now generally used in the discussion of other malformation and diseases. Besides the already existing complications, the unexpected mitochondrial dysfunctions in cloned embryos complicate the cloning process. Thus, it reduces the success rate (Czernik et al., 2017). Several initiatives have, therefore, been implemented to boost the effectiveness of SCNT. These improvements include the technological aspects and the targeted alteration of the donor nucleus before or after the embryo's development (Czernik et al., 2016).

### 3. The application of animal cloning in agriculture

The recent advances in cloning efficiency have enabled diverse applications of SCNT technology. The advancement of SCNT in agriculture enhances the propagation of breeding farm animals and preserve the genetic resources of commercially important species, including cows and sheep (Gomez et al., 2009; Keefer, 2015). The weight of SCNT in the agricultural sector is more significant than in biomedicine. While the scientific and technological challenges

of SCNT in both sectors are similar, employment in agriculture is more productive due to environmental variability and economic factors, such as cost efficiency, unique to agriculture. Cloning can be used to produce animals with desirable traits to yield healthier milk and meat for human consumption (Paterson et al., 2003). The study administered by Takahashi & Yoshihio (2004) compares a sample of meat from cloned embryos, somatic clones and naturally produced animals, indicated no significant biological differences amongst the sample.

Genetically modified clones are considered more desirable than its traditionally bred counterpart, as clones tend to possess improved qualities such as healthier milk, meat and disease-resistant properties, resulting in a flow-on effect to benefit the wider population (Vajta and Gjerris, 2005). One of the limitations of cloning in agriculture is its inability to produce consistent breeding animals' results with the aspired traits (Isa, 2013). It can be explained by the absence of a consistent mitochondrial DNA, as mitochondrial DNA varies according to the donor eggs. Also, the primary explanation for the low cloning competence is assumed to be the inability to reprogram the donor genome (Rodriguez-Orsorio et al., 2012). Further studies to enhance animal cloning efficiency such as bovine are needed to optimise the SCNT stage with an augmented recognition of the reprogramming mechanism (Akagi et al., 2014). Moreover, the implementation of this technology depends not only on the animal's genetic merits but also on the public perception and widespread acceptance of said technology (Vajta and Gjerris, 2005).

### 4. Risk of the animal product derived from a cloned animal

The safety and ethical concerns associated with the products derived from modern biotechnology, especially cloned animals, are still controversial subjects (Hasim et al., 2020). Nevertheless, previous studies have shown that animal products' chemical composition, including meat and milk, is similar between clone-derived and nonclone-derived animals (Hur, 2017). Most animal studies published that consuming meat and milk from cloned animals did not cause health problems and did not produce toxic effects. Dietary meat and milk derived from cloned animals also caused no adverse health effects such as reproduction and allergic reactions in animal models. Therefore, cloned animal meat and milk are as safe as food from their noncloned counterparts and can be consumed as novel foods (Hur, 2017).

### 5. Islamic perspective on animal cloning

With the evolution of animal cloning in agriculture, naturally, the discussion of consuming foods from cloned animals is prompted. As a by-product of modern biotechnology processes, food is a comparatively brand-new concept, which requires new rulings that are more in line with the current developments. Before determining whether it is permissible or forbidden – haram or halal – to be consumed, this food category needs to be critically examined. Through the guidance of al-Qur'an and al-Sunnah (traditions of Prophet Muhammad PBUH), Muslims have relied on clear guidelines to determine the legality of matters. The general parameter on which the permissibility of a matter is based on is that unless something has been proven haram, or possessing haram features, Islam perceives the matter to be halal and permissible. The *fiqh* (Islamic jurisprudence) states:

الأصل في الأشياء الإباحة حتى يدل الدليل على التحريم  
Meaning:

"The original (basic) law for everything is permitted, unless there is an indication that shows the forbidden state of it." (al-Suyuti, 2001, 1:60; Ibn Nujaym, 1985, 1: 109).

Generally, Islam bans matters that are detrimental to one's self. Thus, according to Islamic jurisprudence, the rulings for food as a by-product of modern biotechnology processes such as animal cloning should be determined based on the effects of its consumption by humans and whether it breaches any shariah principles. Following this belief, Muhammad Sulaiman al-Ashqar (2006) established the importance of Islamic organisations in examining the effects of food and medicinal products to provide a clearer understanding that can determine the permissibility of said food. Besides, the *muftis* are also accountable for researching animal-based food products, especially those produced through modern cloning methods (Arifin, 2019). Hence, the Islamic authority needs to engage in extensive reviews regarding modern biotechnological processes, including animal cloning, to decide its permissibility in an Islamic context.

### 5.1. The determination of the permissibility of food derived from cloned animals

The permissibility of food's analysis in this study is limited to the subject of food as a by-product of the modern biotechnological process of animal cloning. It is because cloning is generally performed as a means of breeding, for human consumption. It is vital to ensure that all new animal-based products produced through modern biotechnology must comply with the Quran and Sunnah requirements. (Kashim et al., 2020). The views of the *fuqaha'* regarding the permissibility of food derived from animals suggest that six principles could be used as a guideline in concluding the rulings of cloned animal-derived food. The principles are:

#### a) Principle one: *Halal* and *haram* animals

A modern food product produced from *halal* animals is deemed *halal* (Husni et al., 2015; Kashim et al., 2018). Following this principle, any food produced through biotechnological processes to cater to the modern Islamic community should first assess the permissibility (*halal* or *haram*) of the types of animals that form the basis or foundation of the developed food product (Husni et al., 2012). It is fundamental to ensure that the benefits of food products produced through modern biotechnology application could be preserved (Al-Bakri, 2019).

#### b) Principle two: Islamic process of animal slaughtering

There are essential conflicts of opinion between the *Fuqaha'* in regards to the concept of *al-dhakah*. It happens due to the distinct understanding of the *dalil* for the process of slaughtering found in the Quran, the Sunnah, or through the practices of the Sahabahs (al-Tariqi, 1983; Rahman et al., 2018). The process of slaughtering requires the rupture of three critical veins: *halqum* (*trachea*); *maryi'* (*oesophagus*); and *wadajay* (*jugular*). Therefore, cloned animals should benefit the Islamic community in every aspect and be slaughtered according to these principles (Kashim et al., 2017).

#### c) Principle three: Not derived from a source of *najis* (impurity)

Cleanliness is one of Islam's most critical aspects. Hence, it should also be considered in producing food derived from cloned animals (Rahman et al., 2018). According to the Islamic Shariah, there are various sources of *Najis* (impurity), such as carcasses that were not slaughtered or animals that were cloned from an animal that is classified as *Najis*. For a cloned animal-derived food product to be defined as clean, and not a *Najis*, it should adhere strictly to the conditions as set out in the Islamic law, and not be contaminated with any sources of *Najis*, including flowing blood (*al-masfuh*) (Kashim et al., 2015). According to Malaysian Standard

(2019), in MS1500:2019 document, *najis* is defined as matters that are impure according to Shariah law and fatwa (Kashim et al., 2017).

Adherence to Islamic law should be emphasised as many studies attended on animal cloning that does not comply with Islamic law. For instance, transgenic paddy production requires cloning pig DNA in paddy plants that aim to develop paddy plants resistance to herbicides, which could increase rice production (Kawahigashi et al., 2005). Additionally, there is also cloning of rat genes in potato trees for the same purpose (Yamada et al., 2002). These animal cloning products are contrary to Islamic rules because there has been a mixing of *haram* and *halal* sources. On that basis, Malaysia's mufti has banned such cloning to protect Muslims' rights (Federal Territory Mufti, 2020).

Blood is often used in food processing. There are two contrasting forms of blood, the flowing and non-flowing blood. Both hold different laws. The four Madhab jurists have banned its use in all food products for the flowing blood, including GMOs. While non-flowing blood such as the liver, spleen, blood attached to animal flesh is *halal* eaten by Muslims (al-Nawawi t.th; al-Zuhayli 1998). Therefore, non-flowing blood in the processing of animal cloning products is considered *halal* following Islamic law (Federal Territory Mufti, 2020). Based on the fatwa, cloning-based food products from animal sources should be determined on a case-by-case basis. Consequently, in the legal issue of a clone-based product's impurity, it needs to be decided based on the origin of the material taken.

#### d) Principle four: *Istihalah tammah* (perfect substance change)

The concept of *Istihalah* closely relates to aspects of cleanliness and purity (*taharah*), especially in the discussion of the modern biotechnological process of animal cloning. The Prophet Muhammad PBUH characterised cleanliness as one of the sources of Iman (faithfulness) of a Muslim (Qazzafiy, 2008). *Istihalah tammah* in animal cloning derived food is essential due to its purpose to purify impurities from contaminated substances. This process removes impurities from the originating body after it has been transferred into the new body.

The process of *Istihalah*, to purify *Najis*-contaminated substances, can either take place naturally or through human intervention. Substances' status that was previously deemed *haram* could be changed to become *halal* and, in turn, be optimally used in various industries. For instance, the consumption or use of wine in food is *haram*. Nevertheless, through the process of *istihalah*, the wine can be fermented and turned into vinegar, which is *halal* to be consumed and used in food. Vinegar is considered *halal*, in contrast to its *haram* original form (wine), as the characteristics associated with wine, such as its smell, taste, and colour can no longer be identified. In line with this concept, food derived from the modern biotechnological process of animal cloning may be categorised as *halal*, given that it undergoes the process of *istihalah tammah* (Kashim et al., 2019).

#### e) Principle five: *Maslahah* (public interest) and *mafsadah* (damage)

The Islamic jurisprudence (*fiqh*) scholars have defined the *maslahah* concept (public interest) as a method to confirm the permissibility of a matter based on serving the interest of the Muslim community – whether it is useful or poses harm (al-Ghazali, 1992; Ibn Abd al-Salam, 2000). Al-Shatibi (1997) described *maslahah* as a process to ensure the continuity and livelihood of the human life, while other Islamic jurisprudence scholars defined *maslahah* as a necessity allowed by the shariah, to preserve one's faith, soul, intellect, family and wealth (Kashim et al., 2019).

The *Ulama'* (Islamic scholars) agreed that in assessing the *maslahah* (public interest), and ultimately the permissibility of a matter, the interests to be served must satisfy the requirements of the *Shariah* (Islamic law). The *maslahah* (public interest) concept as a basis of law, must consider the five most influential factors that need to be preserved: religion, life, intellect, family and wealth (al-Shatibi, 1997).

*Mafsadah* (damage), on the other hand, is a notion that is contrary to *maslahah* and is defined as something that causes harm in society, and which has been denied by Islamic law, due to its unfavourable impressions on religion, life, intellect, family and wealth (Ibn Ashur, 2007).

Islam places high importance on the *maslahah* (public interest) of its followers in all aspects of life, including the effects of food produced through the modern biotechnological process of animal cloning (Isa, 2013). The guideline in determining the permissibility of a matter in the context of Islamic law is commonly following the Islamic jurisprudence objectives of benefiting humankind and preventing harm from them. In the context of food, Allah has ordained upon Muslims to consume healthy, beneficial food while avoiding the contaminated and unhealthy food (Kashim et al., 2020). However, in studying the *maslahah* of a matter, the benefits or the public interest should always adhere to the conditions set out in *Shariah* (Islamic law), to prevent the abuse of the concept of *maslahah*.

Based on researchers' discussion on the *maslahat* and *mafsadah*, contemporary scholars have approved all types of animal cloning processes that lead to *maslahat*, such as medicines' production to preserve human life (Maqasid al-Syariah). Islam also supports cloning in the agricultural sector if it can positively impact a country's economy and as long as it does not abuse the transgenic animals (Federal Territory Mufti, 2020).

Nevertheless, contemporary scholars have banned all types of cloning processes that cause *mafsadah*, which induce harm to humans and animals (Arifin, 2019). Islamic scholars in human cloning domain have declared an absolute ban. It is because human cloning does not meet the needs of *maslahat* but instead leads to greater *mafsadah*. For instance, ideas and studies on human cloning have insulted human glory created only by Almighty God. It worsens when cloning against humans will endanger lives and found various criminal offences in the future. Thus, prevention is better than cure (Kashim et al., 2020).

f) Principle six: *Darurat* (exigency) of animal cloning

*Darurat* (exigency) refers to a situation that necessitates immediate action, and at which people often act irrationally and perform prohibited acts to protect their religion, soul, mind, family and wealth (al-Suyuti, n.d.). The *fuqaha* (scholars) have agreed that any prohibited acts done to preserve the abovementioned five *maqasid*, during an exigent period is exempted and is considered *halal* (permissible) (al-Ramli, 1987; Ibn Qudamah, 1979). Nonetheless, to prevent the random and liberal use of this exclusion, the determination of a *Darurat* (exigent) situation should be in accordance to the conditions set out in *Shariah* (Islamic law) (Muhammad Adham, 2001; Rahman et al., 2019).

## 6. Conclusion

Animal cloning is a comparably new phenomenon which has amassed critical attention and research by scientists. The evolution of this technology renders imperative benefits, particularly in the biomedicine and agriculture sectors. In biomedicine, the advancement of SCNT could develop animal models to study the pathogenesis of human diseases and established genetically engineered xenograft organs for patient transplantation. Still, as much as numerous benefits it offers, animal cloning is exposed to some

risks, including deformation and abnormalities related to the *Large Offspring Syndrome* (LOS). In addition to scientific concerns, animal cloning's biotechnological process also exhibits some ethical issues such as 'playing God' and the technology's abuse to clone other humans. From an Islamic viewpoint, the rulings of animal cloning's permissibility could vary according to current circumstances and *fatwas*. The permissibility of animal cloning in Islam's context depends essentially on its impacts on the Muslim community's interests (*maslahah*) and whether there is an exigent need (*Darurat*) for said process.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgement

We thank the research project grant code FRGS/1/2019/SSI03/UKM/02/1 and FRGS/1/2017/SSI12/UKM/01/1 by Ministry of Higher Education, Malaysia for the supports.

## References

- Ibn Abd al-Salam, Abu Muhammad, A.A.A., 2000. *al-Qawa'id al-Kubra, al-Mausu'ah bi Qawa'id al-Ahkam fi Islah al-Anam*. Dimashq: Dar al-Qalam. Jil. 1.
- Akagi, S., Matsukawa, K., Takahashi, S., 2014. Factors affecting the development of somatic cell nuclear transfer embryos in Cattle. *J. Reprod. Dev.* 60 (5), 329–335. <https://doi.org/10.1262/jrd.2014-057>.
- Al-Bakri, Z.M., 2019. *Irsyad al-Fatwa. Penentuan hukum teknologi haiwan moden menurut Islam*. Malaysia: Jabatan Mufti Wilayah Persekutuan.
- al-Ghazali, M.M., 1992. *al-Mustashfa fi Ilmi al-Usul*. al-Qaherah: Dar al-Haramayn.
- al-Ramli, M.I.A.A., 1987. *Nihayat al-Muhtaj ila Sharh al-Minhaj fi al-Fiqh 'ala Madhhab al-Imam al-Shafi'i*. Beirut: Dar al-Gharb al-Islami.
- al-Shatibi, I.M., 1997. *al-Muwafaqat fi Usul al-Shari'ah* (Vol. 2). Beirut: Muassasat al-Risalah.
- al-Suyuti, A.A.A.B., 2001. *al-Ashbah wa al-Nazair fi Madhhab al-Shafie* (Vol. 1). Beirut: Dar al-Kutb al-Ilmiyyah.
- al-Tariqi, A.M., 1983. *Ahkam al-Dhaba'ih wa al-Luhum al-Mustawradah fi al-Shari'ah al-Islamiyyah*. Beirut: Muassasah al-Risalah.
- Amin, L., Jamaluddin, M.J., Abdul Rahim, M.N., Osman, Mohamad, Nor Muhammad, M., 2009. Factors affecting public attitude toward genetically modified food in Malaysia. *Sains Malaysiana* 35 (1), 55.
- Arifin, L., 2019. *Berita Harian*. Sains, teknologi bantu penelitian hukum isu semasa. Malaysia: Kuala Lumpur.
- Ibn Ashur, Muhammad Tahir, 2007. *Maqasid Shariah al-Islamiyyah*. al-Qaherah: Dar al Salam.
- Ayala, F.J., 2015. *Cloning human? Biological, ethical, and social considerations*. *PNAS* 12 (29), 8879–8886.
- Benagiano, G., Primiero, F.M., 2002. *Human reproductive cloning*. *Int. J. Gynecol. Obstet* 79, 265–268.
- Burgstaller, J.P., Brem, G., 2017. Aging of cloned animals: a mini-review. *Gerontology*; 63:417–425. doi: 10.1159/000452444
- Committee on science, engineering and public policy, national academy of sciences, national academy of engineering, institute of medicine. 2002. Retrieved from <https://www.nap.edu/initiative/committee-on-science-engineering-and-public-policy>
- Czernik, M., Iuso, D., Toschi, P., Khochbin, S., Loi, P., 2016. Remodeling somatic nuclei via exogenous expression of protamine 1 to create spermatid-like structures for somatic nuclear transfer. *Nat. Protoc.* 11 (11), 2170–2188. <https://doi.org/10.1038/nprot.2016.130>. Epub 2016 Oct 6.
- Czernik, M., Toschi, P., Zacchini, F., Iuso, D., Ptak, G.E., 2017. Deregulated expression of mitochondrial proteins Mfn2 and Bcln3L in placenta from sheep somatic cell nuclear transfer (SCNT) conceptuses. *PLoS ONE* 12, (1). <https://doi.org/10.1371/journal.pone.0169579> e0169579.
- Czernik, M., Anzalone, D.A., Palazzese, L., Oikawa, M., Loi, P., 2019. Somatic cell nuclear transfer: failures, successes and the challenges ahead. *Int. J. Dev. Biol.* 63(3–4–5):123–130. <https://doi.org/10.1387/ijdb.180324mc>.
- FDA, 2008. *Animal Cloning: A Risk Assessment*. Rockville, MD, USA: Center for Veterinary Medicine, US Food and Drug Administration.
- Fiester, A., 2005. *Ethical issues in animal cloning*. *Perspect. Biol. Med.* 48 (2), 328–343.
- Gomez, M.C., Pope, C.E., Ricks, D.M., Lyons, J., Dumas, C., Dresser, B.L., 2009. *Cloning endangered felids using heterospecific donor oocytes and interspecies embryo transfer*. *Reprod. Fertil. Dev.* 21, 76–82.
- Harris, J., 1997. "Goodbye Dolly" The ethics of human cloning. *J. Med. Ethics* 23, 353–360.

- Hasim, N.A., Kashim, M.I.A.M., Othman, R., Yahaya, M.Z., Khalid, R., Samsudin, M.A., 2016. Haid daripada Perspektif Sains dan Maqasid Syariah. *Sains Malaysiana* 45 (12), 1879–1885.
- Hasim, N.A., Amin, L., Mahadi, Z., Mohamed, Yusof, N.A., Che Ngah, A., Yaacob, M., Olesen, A.P.O., Abdul Aziz, A., 2020. The integration and harmonisation of secular and Islamic ethical principles in formulating acceptable ethical principles in formulating acceptable ethical guidelines for modern biotechnology in Malaysia. *Sci. Eng. Ethics* 26, 1797–1825.
- Hur, S.J., 2017. A study on current risk assessments and guidelines on the use of food animal products derived from cloned animals. *Food Chem. Toxicol.* 108 (Pt A), 85–92. <https://doi.org/10.1016/j.fct.2017.07.047>.
- Husni, A.M., Nor, A.H.M., El-Seoudi, A.W.M.M., Ibrahim, I.A., Laluddin, H., Samsudin, M.A., Omar, A.F., Alias, M.N., 2012. Relationship of maqasid al-shariah with qisas and diyah: Analytical view. *The Social Sci.* 7 (5), 725–730.
- Husni, A.M., Nasohah, Z., Kashim, M.I.A.M., 2015. Problem of domestic violence and its solutions in the light of maqasid shariah. *Asian Social Sci.* 11 (22), 33–42.
- Ibn Qudamah, Abd Allah ibn Ahmad. 1979. *al-Mughbi fi Fiqh Imam al-Sunnah Ahmad ibn Hanba* (Vol. 9). Beirut: Dar al-Fikr.
- Ibtisham, F., Yanfeng, N., Wang, Z., et al., 2016. Animal cloning drawbacks an overview. *J. Dairy Vet. Anim. Res* 3 (4), 3–7.
- Ibtisham, F., Fahd Qadir, M.M., Xiao, M., An, L., 2017. Animal cloning applications and issues. *Russian J. Genetics* 53 (9), 965–971.
- Isa, N., 2013. *Etika Dalam Bioteknologi Moden: Kajian ke atas Respons Para Ilmuwan Islam Terpilih Mengenai Garis Panduan Etika Islam*. Universiti Malaya, Tesis PhD.
- Kashim, M.I.A.M., Majid, L.A., Adnan, A.H.M., Husni, A.M., Nasohah, Z., Samsudin, M.A., Yahaya, M.Z., 2015. Principles regarding the use of haram (forbidden) sources in food processing: A critical Islamic analysis. *Asian Social Sci.* 11 (22), 17–25.
- Kashim, M.I.A.M., Hasim, N.A., Othaman, R., Yahaya, M.Z., Khalid, R., Samsudin, M.A., Zin, D.M.M., 2017. Plasma darah dalam makanan dari perspektif Islam dan sains. *Sains Malaysiana* 46 (10), 1779–1797.
- Kashim, M.I.A.M., Alias, M.N., Zin, D.M.M., Said, N.L.M., Zakaria, Z., Salleh, A.D., Jamsari, E.A., 2018a. Istihalah and its effects on food: An Islamic perspective. *Int. J. Civil Eng. Technol.* 9 (1), 755–762.
- Kashim, M.I.A.M., Hasim, N.A., Othaman, R., Khalid, R., Samsudin, M.A., Yahaya, M.Z., Abdul Manaf, Z., Amin, L., Mat Zin, D.M., 2018b. *Najis (Tinja) manusia daripada perspektif sains dan Islam serta amalan pemakanan sunnah*. *Sains Malaysiana* 47 (6), 1227–1234.
- Kashim, M.I.A.M., Mohamad, M.N., Sukor, A.S.A., Adnan, N.I.M., Safiai, M.H., Jamsari, E.Z., 2019. Animal urine therapy according to Islamic and scientific perspectives. *Int. J. Civil Eng. Technol.* 10 (02), 2280–2286.
- Kashim, M.I.A.M., Ab Rahman, Z., Mohd Noor, A.Y., Md Sham, F., Hasim, N.A., Safiai, M.H., Mokhtar, M.H., Hamjah, S.H., 2020. Principles regarding the use of haram sources in modern food products: An Islamic perspective. *J. Crit. Rev.* 7 (6), 1017–1024.
- Kawahigashi, H., Hirose, S., Ozawa, K., Ido, Y., Kojima, M., Ohkawa, H., Ohkawa, Y., 2005. Analysis of substrate specificity of pig CYP2B22 and CYP2C49 towards herbicides by transgenic rice plants. *Transgenic Res.* 14 (6), 907–917.
- Keefer, C.L., 2015. Artificial cloning of domestic animals. *Proc. Natl. Acad. Sci. U.S.A.* 112, 8874–8878. <https://doi.org/10.1073/pnas.1501718112>.
- Larjani, B., Zahedi, F., 2004. Islamic perspective on human cloning and stem cell research. *Transpl. Proc.* 36, 3188–3189.
- Loi, P., Iuso, D., Czernik, M., Ogura, A., 2016. A new dynamic Era for somatic cell nuclear transfer? *Trends Biotechnol.* 34, 791–797. <https://doi.org/10.1016/j.tibtech.2016.03.008>.
- Malaysian Standard, 2019. MS1500: 2019 Halal Food-General Requirements (Third Revision). Department of Malaysia Standard: Malaysia
- Matoba, S., Zhang, Y., 2018. Somatic Cell Nuclear Transfer Reprogramming: Mechanisms and Applications. *Cell Stem Cell.* 4;23(4):471–485. doi: 10.1016/j.stem.2018.06.018. Epub 2018 Jul 19. PMID: 30033121; PMCID: PMC6173619.
- McCreath, K., 2000. Production of gene-targeted sheep by nuclear transfer from cultured somatic cells. *Nature* 40, 1066–1069.
- Muhammad Sulaiman al-Ashqar, 2006. *Abhath Ijtihadiyyah fi al-Fiqh al-Tibb*. Dar al-Nafa'is, Beirut.
- Niemann, H., 2016. Epigenetic reprogramming in mammalian species after SCNT-based cloning. *Theriogenology* 86 (1), 80–90.
- Ibn Nujaym, Zayn al-Abidin, 1985. *al-Ashbah wa al-Naza'ir ala Madhhab Abi Hanifah al-Nu'man* (Vol. 1). Beirut: Dar al-Kutb al-Ilmiyyah.
- Paterson, L., Desousa, P., Ritchie, W., King, T., Wilmot, I., 2003. Application of reproductive biotechnology in animals implications and potentials. *Applications of reproductive cloning. Anim. Reprod. Sci.* 79, 137–143.
- Phillips, K., 2002. Disease-resistant bull cloned at Texas A&M. Retrieved from: <http://www.tamu.edu/aggedaily/press/020214cc.html>.
- Rahman, Z.A., Ismail, A., Abdullah, S.N.H.S., Fauzi, W.F., Suradi, N.R.M., 2018a. Developing self-identity among teens towards personal empowerment. *Int. J. Civil Eng. Technol.* 9 (13), 674–684.
- Rahman, Z.A., Noor, A.Y.M., Abdullah, S.N.H.S., Shaari, A.H., Sarnon, N., 2018b. The relationship of Islamic cognitive reasoning elements and Islamic psychosocial as pillars in the self-empowerment of risky teenagers. *Int. J. Civil Eng. Technol.* 9 (8), 1140–1150.
- Rahman, Z.A., Ahmad, Y.M.N., Yusof, M.B., Mohamed, S.B., Kashim, M.I.A.M., 2019. Influence of prayers coping in problematic behaviors. *Int. J. Civil Eng. Technol.* 10 (2), 826–835.
- Rodriguez-Osorio, N., Urrego, R., Cibelli, J.B., Eilertsen, K., Memili, E., 2012. Reprogramming mammalian somatic cells. *Theriogenology* 78 (9), 1869–1886. <https://doi.org/10.1016/j.theriogenology.2012.05.030>.
- Samsudin, M.A., Yahaya, M.Z., Kashim, M.I.A.M., Hayatullah, L., Ahmad Munawar, I., Rozida, M.K., Irwan, M.S., Syed Azhar, S.S., 2015. Establishment of Shari'ah supervisory committee in Hospital: An analysis from perspective of public interest. *Asian Social Sci.* 11 (4), 43–47.
- Takahashi, S., Yoshio, I., 2004. Evaluation of meat products from cloned cattle: biological and biochemical properties. *Cloning Stem Cells* 6, 165–171.
- Thomas, T., 2003. Cloned and genetically engineered animals. *Humane Society of the United States*. Retrieved from: <http://www.hsus.org/ace/15401>
- UNESCO, 2005. *Universal Declaration on Bioethics and Human Rights*.
- Vajta, G., Gjerris, M., 2005. Science and technology of farm animal cloning: start of the art. *Animal Reprod. Sci.* 92 (3), 211–230.
- Yamada, T., Ohashi, Y., Ohshima, M., Inui, H., Shiota, N., Ohkawa, H., Ohkawa, Y., 2002. Inducible cross-tolerance to herbicides in transgenic potato plants with the rat CYP1A1 gene. *Theor. Appl. Genet.* 104 (2–3), 308–314.
- Zin, D.D.M., Mohamed, S., Kashim, M.I.A.M., Jamsari, E.Z., Kamaruzaman, A.F., Rahman, Z., 2019. Teachers' knowledge and practice in implementing the thematic approach in pre-school. *Int. J. Civil Eng. Technol.* 10 (01), 1870–1881.